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Native poleros bringing cord wood to market.

TRANSPORTATION ON THE MAGDALENA RIVER, COLOMBIA (see page 88).

Some Aspects of Hindu Life in India*

An Intimate View of the Family and the Relations of Its Members

By Bhupendranath Basu, Member of the Council of India

I have chosen as the subject of my paper "Some Aspects of Hindu Life in India." I shall not dwell on those aspects of our life which lie on the surface and which are, more or less, known to the European sojourner in India. My story may not appeal to those whose imagination about countries to the east of a certain longitude is colored mostly by the old-world romance of the "Arabian Nights" or the modern glamor of Kipling. To those it may sound like dripping waters over an unfamiliar soil. But though my story may lack the elements of romance and poetry, I hope it will not be altogether uninteresting; it relates to a life which has been flowing in a continuous though much broken stream, through the long glades of time where the dim past mingles its shadows with the living present, and imparts to it a mellowed and sanctified charm.

From nearly all seats of past civilisation the old life has vanished, but not yet from India. May I for a moment pause on this wonderful vitality of the life into the interior of which I shall ask you gently to follow? I do not propose to detain you long. But this feature of Hindu life must strike even a most casual observer. It is not explained by merely saying that the East is East, for the meridians are merely physical and not psychological lines. You must search deeper. The Hindu is no aggressive proselytiser; he has, indeed, admitted many communities into the folds of his faith, but he has never tried to force its unwilling acceptance. He has a well-defined mental attitude as regards other faiths. He has never believed that because his faith is best suited to him, therefore other faiths of other peoples must be false. He has never professed to be the sole bearer of an exclusive charter to salvation; he has never massacred, burnt or tortured men or women because they belonged to a different faith; he has given safe asylum to the persecuted of all faiths, ancient Jews, early Christians, and Parsis.

While appreciating good in others, he has adjusted his own beliefs and practice to his own requirements, and never found it necessary to renounce them. There is another trait in the Hindu character which is very strongly marked. The Hindu has realized probably in a far greater degree than any other people the faith of Ecclesiastes, and in his belief that all is vanity lies both his strength and his weakness, his salvation and his ruin. Standing here in the centre of the workshop of the world, it is difficult to say who is right. The Kaiser has gone, but it remains to be seen whether Kaiserdom has vanished, or is going to be transferred from one to the many, for democracies may be quite as unjust and oppressive as autocracies. The Western nations think that they have successfully solved the problem of life. The question is will that solution stand the verification of time? We in India have also solved, or attempted to solve, that problem in our own way. India learnt long ago that man doth not live by bread alone, and therefore she has weathered the storms which through many centuries have blown across her wide expanse, ruffling only the surface of her life.

An understanding of these traits of the Hindu character—toleration towards other faiths and detachment from the world, being in it but not of it—are valuable equivalents to the traveller who wants to tread the corridors that lead into the inner chambers of Hindu life.

At the entrance you meet the venerable structure—the joint family system. It has descended to us from time immemorial, the patriarchal system of old still holding sway in India. The structure, though ancient, is still full of life. The joint family is a small co-operative corporation, in which men and women have a well-defined place. At the head of the corporation is the senior member of the family, generally the eldest male member, but not unoften, in his absence, the senior female member assumes control. All able-bodied members must contribute their labor and earnings, whether of personal skill or agriculture and trade, to the common stock; weaker members, widows, orphans and destitute relations, all must be maintained and supported; sons, nephews, brothers, cousins, all must be treated equally, for any undue preference is apt to break up the family. We have no word for cousins—they are either brothers or sisters—and we do not know what are cousins two degrees removed. The children of a first cousin are young nephews and nieces just the same as the children of your brothers or sisters. The family affections, the family ties, are always very strong, and therefore the maintenance of an equal standard among so many members is not so difficult as it may appear at first sight. Moreover, life is very simple. Until recently shoes were not in general use at home, but sandals without any leather fastenings. I have known of a well-to-do middle-class family of several brothers and cousins who had two or three pairs of leather shoes between them, these shoes being only used when they had occasion to go out, and the same practice is still followed in the case of the more expensive garments, like shawls, which last for generations, and with their age are treated with loving care, as having been used by ancestors of revered memory.

The joint family remains together sometimes for several generations, until it becomes too unwieldy, when it breaks up into smaller families, and you thus see whole villages peopled by members of the same clan. I have said that the family is like a small co-operative society, and it may be likened to a small state, and is kept in its place by strong discipline based on love and obedience. You see nearly every day the younger members coming to the head of the family and taking the dust of his feet as a token of benediction; whenever they go out on an enterprise, they take his leave and carry his blessing. To a Hindu the blessing of the father is like a talisman; for has it not been said of him in our old Scriptures that "the father is heaven, the father is religion, the father is the realisation of the highest penance; if the father is pleased, all the gods are pleased"? But because the father is an object of reverence, he is by no means a distant and forbidding divinity, for on him is laid the injunction that when the son attains the age of sixteen he is to be treated as a friend. Next to the father is the eldest brother, for when the father goes, he takes his place as the head of the family. A beautiful story is told in the Ramayana, one of our great epics, that when Rama, the eldest son of King Dasaratha, who had died, was in exile, his younger brother ruled the State in his name, keeping his sandals on the throne as the emblem of his authority, and when Rama returned to his kingdom after fourteen years of exile, his younger brother came out to meet him at the city gates carrying the sandals on his head.

I have spoken of the father and the eldest brother. I find it difficult to convey to you an adequate impression of the position that the mother holds in regard to her son. Is not God himself worshipped as the great mother? To the son the mother is of greater consideration than the father, for is not Siva the great father shown lying prostrate at the feet of Kali, the mother spirit of the Universe? On leaving home, on returning after an absence, on festive occasions, it is our custom to go to our elders, both men and women, and pay our respects to them, not shaking hands as is the custom here, but bowing our head and taking the dust of their feet when they pronounce their benedictions. If there are several persons present, the obeisance is rendered to them according to their seniority; but if the mother is there, to her we bow first of all, even if members older than the mother may be present. You can repay all services, all kindnesses, either by money, or service, or love, or devotion, but a mother's debt you can never repay. Those of you who have been to India and visited Benares, must have noticed the leaning turrets on the banks of the Ganges. Benares is the holiest city of the Hindus, and temples erected there were considered as earning great merit for both those who built them and those in whose memory they were built. Tradition says that these turrets are the remnants of a Hindu temple which a dutiful son erected to the memory of his dead mother, believing that he would thereby repay the debt which he owed to her. When the temple was completed after several years, for you can even now see it was a great temple of stone, and was about to be consecrated, the son was filled with the pleasure which comes of a duty discharged, and he cried out: "Now, mother, I have after all been able to repay my debt to you," and lo! and behold, the temple began to lean towards the earth and was about to fall, when the pious builder, remembering his blasphemy, exclaimed: "Oh, mother, that art in heaven, truly I am sinful, for how can I think of repaying my debt to thee!" and the fall of the temple was arrested, but the leaning turrets still preach a great lesson to devout Hindus who visit Benares. I might give you other stories, but time presses and one will suffice as an illustration.

There are other bonds which bind the family together; the bonds of sympathy, of common pleasures, of common sorrows. When a death occurs all the members go into mourning; when there is a birth or a wedding the whole family rejoices. Then above all is the family deity, some image of Vishnu, the preserver; his place is in a separate room, generally known as the room of God, or, in well-to-do families, in a temple attached to the house, where the family performs its daily worship. There is a sense of personal attachment between this image of the deity and the family, for the image generally comes down from past generations, often miraculously acquired by a pious ancestor at some remote time. You may smile at our simple faith; but there we are in the midst of our daily life, amidst our joys and sorrows, amidst festive weddings and mournful funerals, in constant contact with the Divine Presence symbolised by the image; and the home to the Hindu becomes sanctified as the house of his God, where sinful thoughts would be a sacrilege. In the early morning you see the girls of the family dressed in pure silken clothes bringing to the little temple offerings of flowers with the soft dew of the night still on them, and fragrant sandal paste. You see them cleaning the temple with their little hands, and making patterns of carpet on the floor with dry paint gathered from flowers. The scent of the flowers, of the sandal paste, and of burning incense fills the house; the elder women come after their morning ablutions, clad in fresh clothes, and see that everything is in order; then the priest comes, little lamps filled with butter are lighted, the conch shell sounds, the bell rings, and the worship begins; and men and women all come and bow their heads in prayer and in meditation. Sometimes children make a noise and disturb the worship, and mothers hush them into silence; but though we mere mortals are disturbed in our prayers by the noise of children, our family deity loves them, and sometimes he reveals himself to the mothers in dreams and tells them not to scold the children, for he loves to be in their midst and hear their voices. I know of an instance where, in a well-to-do family, the temple stood a little apart from the house. The family deity appeared to the master in a vision, and bade him build a temple in the inner courtyard, where the children might play round him. These form the nexus of the Hindu family—the father, the mother, the family deities.

With the household gods is intimately associated the family priest, so obnoxious to the superficial critic, for does not the priest live as a parasite on his flock? I have not much intimate knowledge as to how priests are maintained in European countries; probably a priest would be looked upon as a parasite in any country where exchange is thought of in terms of material goods; but men do not live by the rules of the marketplace, and souls are not weighed in the balance of trade; and I trust, even in the countries from where men and women go on mission work, priests are not looked upon as marketable commodities to be shipped to distant parts. The Hindu priest is a member of the village community, and is a part of the family life of his flock, between whom and himself the tie has existed for many generations. The priest is not generally a man of much learning; he knows, however, the traditions of his faith, and, in spite of his ignorance, is the unconscious inheritor of a high degree of spiritual culture and lives up to the ideals of his priestly profession—poverty and service. He is not a very heavy burden, for he is satisfied with little—a few handfuls of rice, a few home-grown bananas or vegetables, a little unrefined sugar made in the village, and sometimes a few pieces of copper are all that is needed. There are no tithes, no state grants. The Hindu family priest may have his faults, for the perfect man is still the aspiration of prophecy, but he is kindly, honest, and leads a simple life; he is truly the Purohita, the well-wisher of the village, as his name implies.

To the family there are many inseparable adjuncts. I have spoken of the poor relations. I think a picture of our family life would be incomplete without the household servants. A female servant is known as the *jhi*, or daughter in Bengal—she is like the daughter of the house; she calls the master and the mistress, father and mother, and the young men and women of the family brothers and sisters. She participates in the life of the family; she goes to the holy places along with her mistress, for she could not afford to go alone, and generally she spends her life with the family of her adoption; her children are looked after by the family. The treatment of men servants is very similar.

*From the *Journal of the Royal Society of Arts.*

These servants, men and women, are generally people of the humbler castes, but a sense of personal attachment grows up between them and the members of the family, and as they get on in years they are affectionately addressed by the younger members as elder brothers, uncles, aunts, etc. It is curious, how, in Hindu life, we strike up a working relationship between the humbler and the higher classes and, though often separated by caste, address each other affectionately as near relations.

In a well-to-do house there is always a resident teacher, who instructs the children of the family as well as other boys of the village; there is no expensive school building, but room is found in some verandah or shed in the courtyard for the children and their teacher, and in summer under the shade of a tree, and into this school low-caste boys are freely admitted. Mr. Adams, who was employed by the East India Company in the early years of the nineteenth century to inquire into the system of indigenous schools, reported that in these schools not only was there a very considerable number of low-caste boys, but sometimes the teachers also belonged to the lower castes. These indigenous schools were not of a very high order, but they supplied an agency of instruction for the masses which was probably not available in many other countries in those days. It is needless to remind you that, apart from these schools, there were great seats of learning, which were maintained by grants and gifts from the wealthier members of the community.

With Hindu life is bound up its traditional duty of hospitality. It is the duty of a householder to offer a meal to any stranger who may come before midday and ask for one. The mistress of the house does not sit down to her meals until every member is fed, and, as sometimes her food is all that is left, she does not take her meal until well after midday lest a hungry stranger should come and claim one. You thus see that the position of the mistress, though one of great authority, is also of considerable responsibility; she has the upbringing of the children, boys and girls; their religious instruction, the care of their material welfare; it is she who arranges their weddings and often determines their future career. Her rule is autocratic but based on love and understanding. In our country a mother-in-law is not an object of terror. When the son marries he does not set up a separate home, but brings his wife, when she is old enough to undertake the responsibilities of married life, to the paternal roof where his mother takes charge of the newly married bride and gradually affiliates her to the life of her new home. It is worthy of note that a motherless young man finds it difficult to get a bride from a well-to-do family, for no man is willing to give his daughter in marriage to a youth who has no mother to take care of the young wife. From the mistress of the house I come to the younger women: the daughter enloys great liberty and is a chartered favorite, for she leaves you soon after marriage, and the daughter-in-law is made much of; the new home must be made sweet to her, so that she may not feel the change, and is she not to be the mother of your grandchildren, sweeter to you in your declining years than ever your own children were when you were younger? Life at home is not so dull to the young women as you may imagine; there is plenty of innocent fun and amusement; when the husband of a newly married daughter visits the home of his wife, the wife's girl friends, her sisters and cousins, are all aglow with excitement, and the poor newcomer has to submit to many practical jokes. Do not think that because our women do not go about they do not dress well. In well-to-do families they wear very expensive silks and muslins, light as gossamer and beautiful as a dream. You may well ask for whom should they dress? Well, they dress for their husbands; the Hindu wife does not care what others may think of her so long as she is acceptable in the eyes of her husband. After all, dress is an expression of beauty, and the sense of the beautiful is inherent in all women.

One hears a great deal of the Hindu woman's love of ornaments; you are told of the large absorption of the precious metals in India. To the Hindu woman, her ornaments are her insurance against rainy days. Banks and insurance companies are unheard of names in India. No husband, no son, however dire may be the necessity, will touch the ornaments of the women folk, but when the wage-earner dies and distress comes, and fatherless children have to be maintained and educated, and unmarried girls have to be married, these ornaments find their way, unknown to the men, to the village money-lenders or the village goldsmith, and the family carries on its life on the once cherished possessions of its womenkind. In all countries, in yours as well as in mine, women have set the example of ungrudging and silent devotion—it is the most precious endowment of humanity.

The younger women of the house, in their own way, assist in the maintenance of the household, in the preparation of food, in keeping the house clean and tidy, in the daily worship and in the performance of religious and social ceremonies, which are very numerous. In the afternoon, after the mid-day siesta, they gather together with the older women, when one of our great epics is read by one of them and listened to by all; these stories are illustrated by the older ladies by references nearer and more personal to life of some past female ancestor or some great lady whom they knew. These stories are the storehouse of our spiritual life. They tell you how in a remote age, in the presence of the gods who were watching from above and the conquering army of her husband, Sita entered the fire to prove her innocence, and not even the ornaments of flowers she was wearing were singed; how Savitri in the olden days overcame the god of death himself by the great purity of her character, and brought back her dead husband to life; how Draupadi animated the drooping spirit of her husband, the King of the Pandavas, whose capital was Indraprastha, the site of modern Delhi, when he was in exile and his fortunes at their lowest ebb; they tell of women's love, of women's sacrifice and devotion; they tell of men, of their strength and their courage and their virtue; and they have passed as golden threads into the texture of our life, imparting to it its strength and beauty.

Of the Hindu wife I dare not speak, for who can sound the depth of her love and devotion? Custom, tradition, religion, have all combined to make her the crowning blossom of Hindu life; to the Hindu husband she is not merely the wife, she is the emblem of prosperity, she is not only his half, but heart of his heart and soul of his soul, and she is more, for she is his redeemer; weak and erring as man usually is, the merits of his wife assure him salvation, for she is his partner for all time, and God will not punish the good for the guilty, but the guilty will be saved so that the good may not suffer.

There are many more things of which I could speak, but time is pressing and your patience must be exhausted. I should like, however, to say something as to how Hindus take their pleasure and amusements. In times of festivals there is usually some musical performance in the house of a well-to-do citizen, when the life of some divine incarnation or mythical hero is represented in action and in song accompanied by instrumental music. The whole countryside come to the performance, and generally spend the whole night there. There are no letters of invitation or cards of admission; all are expected to attend and all are welcome. High and low sit down together on some carpet, or on the bare floor when there is no more room on the carpet. It is interesting to watch the audience. Sometimes you see them laughing at some humorous episode, sometimes weeping at the recital of a tragic event, and sometimes when the story is of great faith and devotion—as of Prahlada, who cheerfully submits to be cast into the flames rather than give up his faith—you see the whole audience deeply stirred, tense with devotional fervor; you feel the flapping wings of the Holy Spirit, and when the story reaches its climax, as when, for instance, Prahlada is saved, the assembled crowd gives a shout and cries out the name of God.

Then we have got the street musicians, who go about with a violin or a single-stringed instrument, called the *ektara;* they are not the organ-grinders of European cities, against whom we see notices put up here and there. There is no prohibition against these musicians going anywhere; they come to our houses before the breaking of the dawn, and, standing outside the door, sing the morning song, calling upon the earth to throw off its mantle of darkness, its unconsciousness of sleep, and greet the rising sun. He is an itinerant philosopher, this street musician of ours, for his songs are the compositions of great men inspired with living faith, and are full of the imagery of village life; one of his songs is a great favorite with us in Bengal—

Like the oilman's bullock with the bandaged eye,
Round and round the wheel we go, but know not why.

This spirit, this belief that the external world is but a delusion is deep-seated in the Hindu mind, and high and low all cherish it; it is this which leads our men and women, when they have lived their life of the world, to retire for meditation, for communion with the Supreme Soul, which is the real essence of the Universe; it would be a mistake, however, to think of the Hindus as lost in contemplation, a mistake into which some Western observers have fallen, and which is probably the inspiring source of those beautiful lines so often quoted:—

The East bow'd low before the blast
In patient, deep disdain;
She let the legions thunder past,
And plunged in thought again.

But just as we realise that the external world is not of the essence, we also realise that activity is the foundation of faith and therefore of salvation, only our activities must not be founded upon selfish aims; it was said in the "Gita," a book of high value to us Hindus, that "work is your field and the fruits thereof," and because we mortals cannot extricate ourselves from the coils of self there is in the Hindu mind always the longing to leave the activities of life when the time comes. And much depends on this limitation of time. For abnegation of the world is not countenanced before worldly duties have been discharged. Our great poet Kalidasa, speaking of a mighty race of kings, says of them that they devoted their boyhood to study, their youth to worldly duties, and their age to asceticism. The householder is regarded with greater favor than a *sanyasi* or ascetic.

Now, much as I should like to speak of other elements in our life, of our marriages, our festivities and our funerals, and of our social system, my time and your patience have their limits, and I must close; but before I do so, I may answer by anticipation the question that may be suggesting itself to some of you, Does Hinduism satisfy the demands of modern enlightenment about religion and life? The same question might be asked of other religions and other systems, but I shall attempt to give a brief reply. In our ancient Scriptures are to be found the highest expression of human aspiration towards the divine. Some of the Vedic hymns, the teachings of the Upanishads, cannot be excelled; these have remained for many centuries, the exclusive possession of the select and the initiated; their great truths were illustrated in the Puranic stories of later times, which were accessible to all. Hinduism had to include in its folds many lower types of civilisation and beliefs, just as even now Christianity in Southern India recognises caste, and in Europe, class divisions; but the select knew the path and also knew that the path might be approached in various ways. When modern thoughts first invaded India early in the last century the higher knowledge was very much confined, and men began to rebel against forms which had become meaningless and often mischievous, and there was great commotion. It seemed as if Hinduism would break at last, but a great Brahmin in Bengal, deeply versed in the religious and philosophic lore of the Hindus, and also deeply read in the Semitic systems of faith, broke the seal which ignorance, superstition, pride and folly had placed upon the sacred Scriptures, and laid them bare to the wondering gaze of the rebellious intelligensia. Others have followed Rammohan Roy-Dayananda Saraswati of the Arya Samaj, Keshab Chunder Sen of the Brahma Samaj, Vivekananda of the Ramkrishna Mission. Their preachings have made the dry bones of the valley instinct with new life; forms have lost their deadness and worship its earthiness; abuses are freely recognised, which is preliminary to their removal, and with the inherited catholicity of their mental attitude the intellectuals find in their own system all that they want, and all that is wanted for the masses; for Hinduism provides, what other religions do not often do, an evolutionary process moving from stage to stage. Our forward thinkers are trying to expedite this process; we see social activities on all sides, a new awakening before a brighter dawn.

I am fully conscious that I have drawn a very incomplete and imperfect picture of Hindu life, but with the time at my disposal I could do no more. I do not know whether the aspect I have chosen will interest you, but it is an aspect not fully realised by outside observers, who see more of the form than of the spirit. I have tried to present this aspect to you from the Hindu point of view. You may not like to look at the picture from where I stand, and you may prefer your own position. So be it. I have no quarrel with you, only you may miss the soul of the picture you are looking at, for, mind you, pictures have souls, as well as men and women.

I must now conclude. If I have succeeded in any degree in placing before you an impression of the subtle charm of Hindu life, which age has not dimmed, if in any degree I have succeeded in showing why the flowing tide of time has not unloosened the holds of its roots on the hearts of our people, I shall consider my task well done. If not, I do not despair, for I look forward on your part to a greater knowledge of my country and of our people, brought so near to you by the common sufferings of recent times, knowledge founded not on ideals of domination or superiority, whether of the missionary or the layman, but knowledge founded on ideals of equality and comradeship; and with better knowledge will come truer appreciation.

The Hero Shrew

Among the Strangest Animals Known

ONE of the rare specimens of animals to be seen at the American Museum of Natural History is the Hero Shrew, a new sort of forest creature and among the strangest animals known.

Its skin and skeleton were brought back to this country by the Lang-Chaplain Expedition who spent six years in the forests of Africa gathering the most extensive and representative collections ever taken out of that country.

In the vast Ituri Forest in the Belgian Congo, where the sun rarely pierces through the dense foliage, and rain pools stand for months in the foot-tracks of the elephants, the "hero shrew" was found. It is a variant of the common shrew which is very widely distributed over the earth, being found in the Arctic circle, Asia, Europe, Australia, England and the Americas.

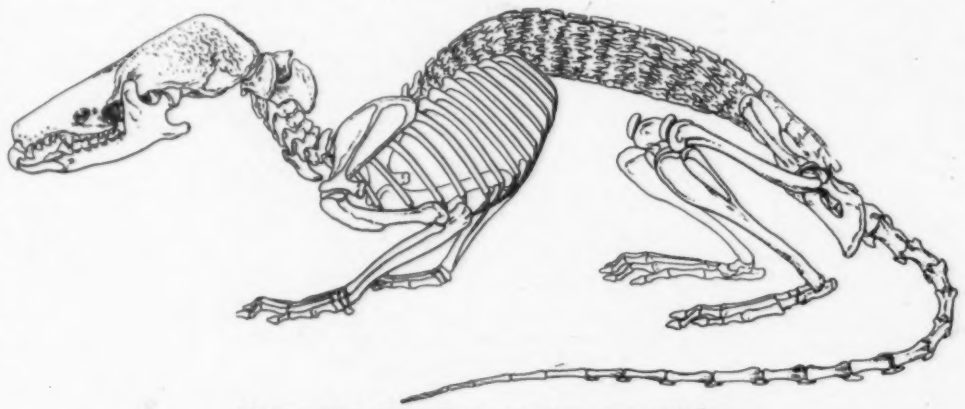
The hero shrew, however, is known from only two localities, both in the Belgian Congo. These are the villages of Medje and Bafwabaka, both situated near the borders of the tropical rain forest, and only about 30 miles distant from each other. Easily recognized among other varieties of shrew by its more clumsy appearance and its longer, dense pelage, the most striking characteristic of the hero shrew is the remarkable strength of its vertebral column. Some interesting proof of the strength of its back is given by Mr. Herbert Lang. He says that the natives of the locality, especially the Mangbetu, delight in performing on captive specimens. "After the usual hubbub of various invocations, a full grown man weighing some 160 pounds steps barefooted upon the shrew. Steadily trying to balance himself on one leg, he continues to vociferate several minutes. The poor shrew seems certainly to be doomed. But as soon as his tormentor jumps off, the shrew, after a few shivering movements, tries to escape, none the worse for this mad experience and apparently in no need of the wild applause and exhortations of the throng." During this demonstration the head is always left free. The heart and other viscera are protected from crushing by the very strong vertebral column, made up of heavy, closely interlocking spines, and curiously convex behind the shoulder, forming there an arch highly resistant to pressure.

The Mangbetu believe that the charred body or heart of the hero shrew, when prepared by their medicine-man, lends the quality of invincibility when worn as a talisman or taken as medicine. Those about to engage in warfare, or setting out on a dangerous enterprise such as elephant hunting, are always eager to carry along some part of a hero shrew as a charm against danger. Their faith in its protective power is doubtless a strong stimulant to courage and quick-wittedness, probably often causing extraordinarily heroic conduct. Without doubt this is the explanation of the name "hero shrew," bestowed by the Mangbetu on this little animal, which scientists call "Scutisorex Congicus."

While the shrew family includes the smallest of all mammals—some being scarcely two inches in length—a fully adult hero shrew measures 8.6" to 9.6" from nose to tip of tail, the latter accounting for about two-fifths of the total length. Scutisorex lives in the forest, making nests under the roots of trees or in any slight depression. His food is insects, grubs, worms, slugs, small frogs, etc. This diet is practically the same as that of its relatives, the moles, and consists only of such creatures as are easily killed by an animal of its size and fairly abundant all over the floor of these tropical rain forests. Its feeding habits therefore offer no explanation of the origin or utility of its enormously strengthened vertebral column.

Its breeding season is from the end of April to the beginning of August, five to seven, and more rarely ten, young being found in the nest. They are naked, blind and toothless, but soon run about snapping at everything within reach. The hero shrew is very largely diurnal, many specimens having been caught during the day time, a few even at noon. Extremely shy, it can seldom be discovered in the dense, sombre undergrowth of its native haunts. Of more sluggish temper than most shrews, its movements are more deliberate, with less of the short, sudden dash which characterizes the movements of so many of the smaller mammals. While the unyielding grip between the sharp row of teeth is quickly fatal to its prey, it never shows the aggressive boldness of related species; nor are its attacks marked by the nervously rapid and jerking movements that serve with so many insectivores not only instantly to overawe their quarry, but as a protection against defensive attack.

A fine specimen of the Hero Shrew



Skeleton of the Hero Shrew, showing strong vertebrae

Shock in Hydraulic Systems

MR. ALFRED TOWLER, M.I.Mec. E., of the Leeds Engineering and Hydraulic Company, Limited, read recently, before the Leeds Association of Engineers, a paper in which he stated that shock in hydraulic systems could be ameliorated by interposing some form of cushion or relief at the zone of maximum intensity. The term "momentum valve," he added, was a misnomer; it was not a valve in the strictest sense—and would be better called momentum or shock absorber, or alleviator, as was now more common. These devices were usually spring-loaded; in large sizes there were several tiers of springs, and several springs in each tier; this was for the purpose of manufacture and to minimise risks in case of spring failing. Sometimes the device was combined with a relief valve so as to let a relatively small quantity of water escape when a predetermined pressure had been exceeded. The speaker's works were situated at one end of Leeds Waterworks service main, which was subject to the pulsations of pressure or shock waves, and by opening a stop valve a very little the pulsations ceased. As a general precaution in a hydraulic system the speaker recommended a large combined momentum and relief valve being located near the accumulator and an alleviator near each pump and hydraulic machine, but the details of the installation should be in proportion and the whole arranged with inteligence in every case, to arrive at the best results. Weight-loaded accumulators were not ideal, on account of the loading, or the mass, which was not sufficiently sensitive and often increased shock, particularly if the accumulator was on the small side. On board, where accumulators were subject to the rolling and pitching of the ship, the loading was generally done by steam; on land, the speaker was strongly of opinion that compressed air was the best medium for loading hydraulic accumulators and alleviators which really were accumulators in miniature. Mr. Towler proceeded to say that it was undesirable to employ air vessels on the delivery side of hydraulic pumps, because the air escaped whenever the pressure fell; not only was it expensive to replace, but air in hydraulic mains was a source of danger on account of the liability of air locks. It would be understood that in the air loaded accumulators and alleviators recommended, the compressed air was confined in a separate vessel from the water, and should the pressure of the latter fall, the former could not be released. Air vessels on the suction side of pumps were sometimes objected to because they were alleged to have a habit of getting full of water, or empty; if the former, some means should be provided to replenish the air, and, if the latter, it was clear that there was an insufficient water supply to the pump—either the pipes were too small, or there was not a sufficient head. All air vessels should be supplied with water gauges and air-charging devices, and needed periodical attention; the correct water-level generally indicated favorable suction conditions, which were essential to the satisfactory and efficient working of hydraulic pumps.—*Engineering.*

New Elements in Mortar

THE author reports on the use of pure hydrated lime and hydrated cement (Muhlen, Ger. Pats. 294,825, 300,397 and 301,118, *Jour. Soc. Chem. Ind.*, 1916, 1109), as ingredients of mortar. Tests of mortar made with hydrated lime (produced by passing slaked lime through an air-separator), showed no expansion. Lime-sand bricks made with this lime are much stronger than those made with ordinary slaked lime. Pure hydrated lime should also meet a widefelt want in the plaster trade. The coarser silicious and aluminous particles which are removed from slaked hydraulic lime by an air-separator, yield a good bag lime when ground with quicklime, provided that the additional slaking required by such limes is properly effected. Calcined marl or cement-slurry which has been burned with an excess of lime and then hydrated by steam also produces a non-expanding mortar. The setting time varies with the percentage of lime and the mode of preparation of the material. The samples examined passed the standard tests and also the boiling and hot water test satisfactorily. Tests of the tensile strength were also satisfactory considering the high percentage of lime. These new ingredients facilitate the preparation of new kinds of dry mortars, *i. e.*, mortar of pure hydrated lime, cement mortars, and various mixtures for reinforced concrete.—*Note in Jour. Soc. Chem. Ind. on a report by H. Kuhl in Tonind-Zeit.*

Burial Customs and the Belief in Future State

IN Folklore (Vol. XXIX, No. 1), Mrs. M. A. Holland, in a paper entitled "The Influence of Burial Customs on the Belief in a Future State," examines Sir James Frazier's well-known paper, "On Certain Burial Customs as Illustrating the Primitive Theory of the Soul" (Journal of the Anthropological Institute, 1885). The author examines this theory from the preanimistic point of view, and discusses certain customs associated with burial and the modes adopted by early man for the disposal of the corpse. As an illustration of the method of inquiry, she inquires why, according to Plutarch, an exile, reported to be dead, for whom funeral ceremonies have been performed, may not re-enter his house through the door, but must find a way through the roof. The hitherto accepted explanation is that he is still officially dead, must be considered a ghost, and as such, it is physically impossible for him to cross the threshold, which has been rendered ghost-proof by a mystic barrier of fire and water.—*Nature.*

Anomalies in the Animal World—XV

Anomalies Found Among the Invertebrates

By Dr. R. W. Shufeldt

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An authority at hand on zoölogical terminology has defined the *Invertebrata* as follows: "That one of two great divisions of the animal kingdom (the other being the Vertebrata) which includes animals having no spinal column or backbone. It includes seven of the eight main branches in which *Animalia* are divisible, namely *Protofoa*, *Coelenterata*, *Echinodermata*, *Vermes*, *Arthropoda*, *Molluscoidea*, and *Mollusca*, thus leaving only the *Vertebrata* as the remaining subkingdom, of equal rank only with any one of the others, not with them all collectively. The word, however, no longer retains any exact taxonomic significance, being simply used to designate those animals collectively which are not vertèbrated.

"The primary division of the animal kingdom now made is into *Protozoa* and *Metazoa*, and the *Vertebrata* form one of the divisions of the latter, to be contrasted with any one of the prime divisions of the metazoic *Invertebrata*, not with the *Invertebrata* collectively."

It is clear from this definition that to point out a few anomalies of the animals composing the *Vertebrata* is one thing; but to treat the *Invertebrata* in a similar manner is quite another thing. In the first place, some of the great divisions of the latter contain as many forms as all the vertebrated animals in existence put together. Insects may be selected, for example (and these do not include the spiders), and we could write half-a-dozen books on the anomalies of the *Insecta*, of which some 300,000 have already been described by entomologists; and there are probably upwards of 12,000,000 species still unknown to science.

The present chapter, then, is intended to simply point out a few of the anomolies of the non-backboned animals of the world, with the view of exhibiting the characters they represent. Not more than one instance in several thousand, however (of all the great divisions and groups), can be selected for the purpose, and even these can only be touched upon in the most superficial manner possible.

It may be remarked here in passing that there can be no doubt that many millions of species of the *Invertebrata* have become extinct since life first appeared on this planet, and of these, the fossil remains have not been obtained in more than one instance in scores of thousands of others. *Protozoa* and *Rhizopods* were probably abundant in the Achæn Age (Laurentian), between thirty or forty millions of years ago—probably much longer—and of this the evidence is not far to seek. When we come to examine the Silurian fauna, which was several millions of years later, we find that all the great divisions of animals, apart from the Vertebrata, are represented, even crustaceans (trilobites) and worms having evolved. Over one hundred species of trilobites had been described in 1883, and there are now probably many more. These few facts are presented merely to show how thoroughly impracticable it would be to enter, to any extent, upon anomalies among existing *Invertebrata*.

The late Sir William Henry Flower informed his students that "There is probably no class among the Invertebrata which offers so many striking family and individual peculiarities as are to be met with among the *Crustacea*." To the Crustacea belong the lobsters, crabs, prawns, shrimp and their numerous allies, and they are affined with the spiders, scorpions, and other creatures. Thousands of species of them have become extinct; thousands are yet to be discovered, and a perfect host of them have already been described by naturalists.

Turning first to this group, then, anomalies and extraordinary forms are found upon every hand. We may select the common, edible crab of this country as an *ordinary* crustacean of its own kind to start from, and we soon find that we have our hands full, even if we come to study only casually the species of this remarkable assemblage.

Nearly every one has heard of Hermit crabs, of which there are various kinds. They are crabs possessing defenceless caudal parts, to protect which latter they back into empty shells of the whelk-shell order, and occupy the same as their habitations. As these crabs grow, they look for larger shells and occupy them. If a suitable shell cannot be found, they select one in which lives the rightful owner, who is dragged out by the hermit crab, duly despatched and eaten, and the shell used as pointed out.

Tropical species of hermit crabs are so large that they require shells some four inches or more across the opening to accommodate them. It is clear that this species of crab is anomalous, and a very different animal as compared with our edible one.

The Leaf Butterfly (Kalima paralekta) in flight and in repose. After Beddard's colored plate in "Animal Colorations"—natural size.

Fighting or Calling crabs are also worthy of notice, but they have already been referred to in the last chapter.

W. F. Kirby, F.L.S., in speaking of crabs, gives us his idea as to the great variety of them when he says: "Some crabs are smooth and shining, but others are covered with bosses, excrescences, and spines, which give them a very formidable appearance and must be a useful protection against any enemies to whose attacks they are exposed. In many species one of the two great claws is always much larger than the other. Some have round bodies, others are oval or nearly square; some have short legs, and others have long ones. The species differ much in their habits; and in tropical countries there are land crabs that live entirely on shore, and others which are amphibious and are said to climb cocoanut-trees to get at the nuts (*Birgus*), and hence are called "Tree-crabs." As a general rule, however, crabs are carnivorous and marine, and play the part of "sea-scavengers."

Kirby does not mention in his account the curious little Chinese hermit crab that invariably has an anemone attached on its big claw, with which it closes the aperture to its shell, after it draws itself within the same!

Polyps, sponges and hydroids, too, it may be said, often attach themselves to the shells occupied by the hermit crabs of the tropics.

Crabs which eat cocoanuts, mentioned above, are also of the hermit variety, and an East Indian species opens the nuts by inserting its claws into the "eyes" thereof, and then banging the nut on the rocks until it breaks open. Palm-crabs they call this species, sometimes.

Some of the long-legged "Spider crabs" annoy our oystermen a great deal by their preying on those bivalves on the beds; they belong to the triangular crabs, and are sometimes called Sea-spiders on account of their long, slender legs. Their stilt-like legs admit of their stalking over uneven surfaces on the sea-bottom, and at such times they are curious looking creatures, the more so from the fact that they often have hydroids, algæ, and barnacles attached to their hairy bodies, or other inorganic matters mixed up with the former.

Japan has in her fauna the largest of all existing Crustacea, and this happens to be a gigantic spider-crab. One of these seen by me several years ago, measured from tip to tip of the first pair of legs a trifle over twenty feet. Even a crab as big as this, with the barnacles, hydroids and other marine animals attached to its body, may settle down among the rocks on the bottom, with its long legs loosely disposed among the lengthy, waving sea-weed, and it would be quite a pardonable thing were any person, or any other creature, to mistake it for one of the rocks thereabouts, so close is the resemblance at times.

Kirby says it "is related that when the great chemist, Sir Humphrey Davy, was a boy he used to maintain that pain was no evil, until a large crab gripped his toe one day when he was bathing, after which he changed his opinion."

There is a crab called the Stone crab,—a salt-water species,—that occurs on the shores of Long Island Sound, that is a medium-sized species, which, when its legs and claws are drawn up close to its body, very closely to its body, resembles for all the world one of the smooth, light-colored stones on the bottom. It is one of the best, all-round biting crabs known to me, and many years ago one of this species served me in the same way experienced by Sir Humphrey; it became necessary to crush the fellow between two stones and pound its claw to a pulp before relief was obtained. The bitten finger was perfectly numb for an hour afterwards, and the pain did not entirely disappear for several days thereafter.

This "protective mimicry" of crabs recalls what is, perhaps, the most perfect thing of this sort in all nature, the creature itself belonging to the Invertebrata, though a long ways removed from the crabs. Most naturalists are now familiar with the species, but some are not, while it will be new to many interested in natural history lore. It is the Kallima butterfly (see figure) which was discovered and first described by Wallace in his *Malay Archipelago*. "The other species," he says, "to which I have to direct attention is the Kallima paralekta, a butterfly of the same family group as our Purple Emperor, and of about the same

size or larger. Its upper surface is of a rich purple, variously tinged with ash color, and across the fore-wings there is a broad bar of deep orange, so that when on the wing it is very conspicuous. This species was not uncommon in dry woods and thickets, and I often endeavored to capture it without success, for after flying a short distance it would enter a bush among dry or dead leaves, and however carefully I crept up to the spot I could never discover it till it would suddenly start out again and then disappear in a similar place. At length I was fortunate enough to see the exact spot where the butterfly settled, and though I lost sight of it for some time, I at length discovered that it was close before my eyes, but that in its position of repose it so closely resembled a dead leaf attached to a twig as almost certainly to deceive the eye even when gazing full upon it. I captured several specimens on the wing, and was able fully to understand the way in which this wonderful resemblance is produced" (pp. 140, 141).

Another species has been discovered since named *Siderone*. With pardon for this digression and to return again to the anomalies to be found among the crabs.

"Pea-crabs" or "Oyster-crabs" are among the smallest species of the entire grop, and most of us are familiar with them from having found or seen them in those bivalves. Females of these diminutive species (*Pinnotheridae*) inhabit the gill-cavities of oysters on the American oyster-beds, while their partners of the oposite sex swim about outside. This led naturalists long ago to describe them as different species, which was the more pardonable, for the reason that the females and the males do not look much alike.

There is still another species found in mussels. Probably these tiny crustaceans had their enemies which preyed upon them, as they are dainty and tender morsels. This drove the crabs to seek a refuge somewhere, so when pursued they may have run into some gaping oyster on the beds, and the latter, surprised at the sensation caused by the intrusion, would instantly close its two shells tightly, and the frightened crablet would be safe in the soft folds of the oyster's gills. As time pased they became permanent occupants. The male's remaining outside is still to be accounted for, and doubtless there is a good reason for the habit. They may escape their enemies in a similar manner, coming forth again on the next occasion of the oyster opening its shells.

Land crabs fall into the family *Gecarcinidae;* "Fiddler-crabs," a familiar and very interesting species to those who have, at low tide, walked over the salt-water marshes of southern New England, are too well known to demand description here (*Gelasimus*).

Then we have many other species that depart more or less from our *ordinary* blue or edible crab (*Callinectes hostatus*), as the "Racer-crabs" or Horsemen (*Ocypoda*); Rock-crabs of the family *Cancridae* proper; the curious "Box-crabs" (*Calappidae*); the brilliantly colored "Porcelain-crabs" (*Porcellanidae*); the almost equally handsome "Lady-crabs" (*Portunidae*), and a perfect host of others, altogether too numerous to even name in the present connection.

Among the most anomalous crabs are our common "King-crabs," species allied to the long extinct and ancient Trilobites referred to above. An oval, smooth shield-of-mail covers the entire fore-part of their bodies, and they possess a long, hard, spear-like "tail" behind. The writer has frequently captured these as well as their tender young, soft, papery, semi-transparent little fellows, having, after a certain time, a form like their parents (Shores of Connecticut: *Limalus polyphemus*).

The remarkable habits of the Robber Crabs, the Violet Crabs, and various other species have already been described in my book entitled "Chapters on the Natural History of the United States," while extended accounts of the anomalous species occurring in this extraordinary assemblage of the *Crustacea* are extremely numerous throughout biological literature in more languages than one.

Who can say where anomalies begin or cease among the enormous army of different species of Insects in the world? Every genus has its representative *ordinary* species, with an endless array of the anomalous ones; and there are thousands of genera! What can be more marvellous than the metamorphoses of butterflies and moths? or more strange than the history of the seventeen year locust (*Cicada septemdecem*)? The published histories of bees and ants form a small library of themselves, and people still continue to write voluminously about them both.

"*Phasmidae*, or walking-sticks and leaf-insects display, to a marvellous degree, a protective resemblance to the twigs and leaves among which they live. The most remarkable forms live in the tropics; they have large wings which strikingly resemble, in form, color and venation, either living or dry leaves. Upon those species which resemble dry leaves, blotches looking like fungus patches are found. Even the legs may be thin and expanded, resembling foliage. In our country, only the twig-like, wingless forms, or walking-sticks occur. These insects are furthermore protected by changes in color, corresponding with the seasonal color changes in twigs; for the young walking-sticks, which appear in the spring, are green like the twigs, but in the autumn they become gray or brown."[1] The only common northern species is *Diapheromera femorata*. Last summer the Zebra Swallow-tail Butterfly (*I. ajax*) was not uncommon about Washington, D. C., and specimens were taken by me. This beautiful representative of its genus presents an interesting anomaly in that the early spring form (marcellus form) has the tail-elongations of the inferior wings tipped with white, and the specimens are smaller than those that appear later, or the summer form (*ajax*), which has the tails at least two-thirds longer than the spring ones.

Seasonal dimorphism or polymorphism, or the dissimilarity between broods of different seasons is well exemplified in specimens of the Cabbage butterfly, the Spring Azure, and the Gray-vined White, which were imported into this country a few years ago. If kept in a refrigerator during their development, the summer forms of these several species produce butterflies that have the color of the winter forms, which is a most curious fact.

Very few people know that the common black "skating-bugs" they see in groups, "skating" about on the surface of the water in quiet places in ponds and streams, have their eyes divided horizontally into two halves, the upper half being used to look up into the air with, and the lower half down into the water (*Gyrinidae*).

There is, in the East Indies, a whitish and gray caterpillar which is found on the *upper sides* of the leaves upon which it feeds. It has all the appearance of an excremental dropping of some small bird, and one is not surprised that the resemblance is of value to it in protecting it from any caterpillar-eating animal. One day, when a boy, I was engaged in turning over old logs in the woods in search of insects, snakes, and so on, and some ten or twelve new beetles, all of the same species, came to hand. Upon gathering them together, my surprise was considerable to note something like a puff of smoke issue from the end of the abdomen of each insect as it was handled, which was accompanied by a little report that could be distinctly heard several feet away. At the same time my fingers smarted as though touched with caustic. Nothing of this kind had ever come my way before; but an old natural history volume in my library at home furnished the following interesting paragraph: "The Bombadier beetle (*Aptinus ballista*) is provided with a most extraordinary means of defense. It has a large oval abdomen, which secretes a caustic fluid. They live in societies, and when they are attacked or alarmed, they discharge this fluid, which not only makes a loud report, but diffuses a disagreeable and penetrating odor; if the liquid strikes the human skin it produces a blister. The French call this battery of the little bombadiers an *Infernal Machine*, the name given to a terrible engine which was once exploded in the streets of Paris, designed to kill Emperor Napoleon I. In tropical countries, this kind of insect is of large size. An amusing French writer remarks that, if the common European species—there being several kinds—may be considered as provided with muskets, these seem, comparatively, to possess cannon."

Many years ago there was a distinguished friend of mine, a practitioner of medicine in Washington, D. C., who consulted me in reference to a case he had in his practice. His patient was a woman suffering with an abcess of the ear, and one morning the doctor, in examining it, found a large *maggot* in the meatus. He carefully corked it up in a small bottle, and sent for me to examine it. When I arrived at his office, he produced the bottle with great mystery, and with a singular air of confidence that he would furnish an inexplicable problem and an uncommon surprise for me. He, however, was the one to be surprised, for his bottle contained only a dead specimen of a large fly and a pupal case. Being amused for an instant at his apparent astonishment—for he had carefully locked the bottle up in a private drawer and carried the key in his pocket—when it was my turn to be surprised; for, upon casually remarking that metamorphosis had taken place and the fly had died from lack of air, he at once asked me where the fly came *from!*

"The development of flies," says Davenport in his Introduction to Zoölogy, "is rapid. One or two hundred eggs may be laid by a single individual. These, in warm weather, hatch in a few hours into larvæ, commonly called 'maggots.' The larvæ are wholly footless, and even the head is only a slightly developed structure. The larvæ acquire full size in about a week; pupate and hatch about a week later. The process of pupation is a complicated one, for all the larval organs, excepting certain patches of tissue, are destroyed. By the growth of these patches the individual is formed anew. These changes are all deep lying, and nothing seems more passive than the brown pupal case. Finally the case breaks at one end, and the fully formed fly emerges. The metamorphosis which the fly has just undergone is a complete one" (p. 63). My medical friend remarked that he was not an *entomologist;* consequently he knew nothing of such performances, and so felt no shame for his ignorance. Times have changed *somewhat* since those days!

Some ten or twelve years ago, Miss Belle S. Cragin presented me with a copy of her admirable little book on "Our Insect Friends and Foes." On page 259, under the family *Braconidae*, she says: "Perhaps you have seen a tomato-worm that looked as if its back were covered with grains of rice, all stuck on end. They were the cocoons of a tiny insect which laid its eggs within the caterpillar's body by means of its ovipositor. When the eggs hatched, the larvæ fed inside the caterpillar till they were grown, and then came out and made their cocoons on its back. Of course the caterpillar soon died of weakness. When the pupæ were ready to appear as perfect insects, each one cut a tiny round lid from the top of its cocoon, and crawled out. These little parasites are found on other caterpillars, and sometimes you will see them bunched together on grass and weeds. The adults are usually bright-colored, and look like small ichneumon-flies" (pp. 259, 260). This is interesting, not to say anomalous, and young nature students should be encouraged to look further into the life histories of the singular insects of this and related families.

But the anomalies among insects, as previously remarked, are practically endless. One might select, in any tropical forest, a square mile of territory, and it would require a long life indeed, of eight hours per day, devoted to systematic and scientifically directed work, to prepare the life histories of the insects alone to be found in such an area. One may easily imagine from this how many anomalies we would meet with when we came to describe the *unknown* insects of the world; besides, we know as yet but comparatively little about the habits of many insects that have been *discovered* and *named* long, long years ago. Some systematists, indeed, seem to believe that the end and all of zoölogy consists in capturing a new form, ascertaining its genus (if one has already been created to receive it), describing its external characters, naming it, then dropping the specimen in a preservative "for the collection."

Common earth-worms were so treated for a great many years—if permission may now be given me to pass the insects and say a few words about this Order of Annelids, designated as the *Oligochaeta*—until Darwin gave them the attention of his master-mind.[2] He says: "Worms have played a more important part in the history of the world than most persons would at first suppose. In almost all humid countries they are extraordinarily numerous, and for their size possess great muscular power." Remember he is writing about the *common* earth-worms we see all over our sidewalks in most all American towns after a rain-storm in the spring, and similar species abroad.

"In many parts of England," he continues, "a weight of more than ten tons (10,516 kilogrammes) of dry earth annually passes through their bodies and is brought to the surface on each acre of land; so that the whole superficial bed of vegetable mould passes through their bodies in the course of every few years. From the collapsing of the old burrows, the mould is in constant though slow movement, and the particles composing it are thus rubbed together. By these means fresh surfaces are continually exposed to the action of the carbonic acid of the soil, and of the humus-acids which appear to be still more efficient in the decomposition of rocks." In long periods of time—and nature cares nothing about time—such an operation must effect stupendous results. What the outcome may be, Darwin explains in the following forceful words: "The removal of worm castings by the above means leads to results which are far from insignificant. It has been shown that a layer of earth, .2 of an inch in thickness, is in many places annually brought to the surface per acre; and if a small part of this amount flows, or rolls, or is

[1] Davenport, C. B. and Gertrude, C. "Introduction to Zoölogy." N. York, 1900, p. 7.

[2] Darwin, Charles. "The Formation of Vegetable Mould through the action of worms, and observations on their habits." Amer. Ed. N. York, 1882.

washed, even for a short distance down every inclined surface, or is repeatedly blown in one direction, a great effect will be produced in the course of ages. It was found by measurements and calculations that on a surface, with a mean inclination of 9° 26, 2.4 cubic inches of earth which had been ejected by worms crossed, in the course of a year, a horizontal line one yard in length; so that 240 cubic inches would cross a line 100 yards in length. This latter amount in a damp state would weigh eleven and a half pounds. Thus a considerable weight of earth is continually moving down each side of every valley and will in time reach its bed. Finally this earth will be transported by the streams flowing in the valleys into the ocean, the great receptacle for all matter denuded from the land. It is known from the amount of sediment annually delivered into the sea by the Mississippo, that its enormous drainage-area must on an average be lowered .00263 of an inch each year; and this would suffice in four and a half million years to lower the whole drainage-area to the level of the sea-shore. So that, if a small fraction of the layer of fine earth .2 of an inch in thickness, which is annually brought to the surface by worms, is carried away, a great result cannot fail to be produced within a period which no geologist considers extremely long" (pp. 307, 308).

If these earth-worms, which seem to be sufficiently anomalous to merit a notice in the present chapter, continue to *thrive* and *increase*, there will be no need to doubt Darwin's point about the fact that the fine earth annually brought to the surface by worms will be duly carried into the common basin of the oceans in due time, for it is happening every day at the present time.

How few people there are, when they accidentally crush the life out of an earth-worm under foot, who think of such matters—that is, think if these common earth-worms *persist* and *propagate* in sufficient numbers, they will ultimatley level the land areas of the earth, and to a large extent fill up the basins of all the oceans. All the mountains and valleys will be eliminated, leveled, and gone forever, and that within a far less time than geologists allot to the late Pleistocene or Recent Period, or, in fact, the lapse of time actually representing the Recent Period.

A great many of these different kinds of worms (*Vermes*) are known; the list is being continually added to by zoölogists engaged in that line of biological research, and some of the anomalies they present are truly fonderful. Even the common earth-worms considered in the last paragraph belong, by all rights, in such a category. We may keep one for months without food, and it will not starve provided the requisite amount of moisture is supplied it. In a dry atmosphere it will perish in a few hours, but may be kept under water several days without drowning. Cut your specimen of earth-worm in half, and each moiety, if properly cared for, will develop the missing organs of either half, so that *two* perfect worms will result. Finally, the forepart of one earth-worm may be united by its cut or free edges to those of the hind part of another similarly divided specimen, and the two will grow together, a perfect worm resulting. Such anomalous results are worthy of thought sometimes.

Starfishes, which are typical invertebrates, belong to the *Echidnodermata*, and most every one is familiar with the appearance of the common forms of them. Their structure and habits have been closely studied by naturalists, and it is needless to say that they present many most interesting anomalies. They are remarkable for their capacity for regeneration, even from central disks and *a single arm*. This accounts for finding specimens with only three or four rays, and sometimes a small ray interpolated between the original ones, missing parts being in various stages of regeneration.

But, as already pointed out, it would be quite out of the question to even name the anomalies of the invertebrate animals of the world in a series of articles like the present one; only a few striking ones, selected from some of the better known groups, have been touched upon, and in so doing many, many others have, from necessity, been set aside, as the interesting *Coeleurata;* the jelly fish; all the curious hydroids and the corals; sponges, and scores of other groups, to say nothing of the vast hosts of the Protozoa and the Infusoria.

Scientific Glassware

As the result of numerous experiments it has been found that a batch containing 6.5 per cent alumina, about 8 per cent zinc oxide, and about 7 per cent boric oxide gave a satisfactory glass for scientific purposes, provided the silica and alkali were present in the best proportions.

A South Carolina Meteor*

By Richard H. Sullivan, Meteorologist, Weather Bureau Office, Columbia, S. C.

A REMARKABLE meteoric phenomenon was witnessed throughout South Carolina and portions of adjacent States between 7:20 and 7:42 p. m., Eastern Standard (75th Mer.) Time, on April 23, 1918.

The meteor came out of the firmament from the north like a flash of lightning, and exploded with three distinct prongs of light like an immense skyrocket. It cast a noticeable glare on the twilight, and left a cloud of whitish-gray smoke or cosmic dust suspended aloft similar in many respects to a cloud from a shrapnel shell or aerial dynamite bomb. The position of the meteor at the time of explosion, as closely as could be ascertained, was as follows: As viewed from Charlotte, N. C., altitude 65°, azimuth 60°; Charleston, S. C., altitude 10°, azimuth 155°; Columbia, S. C., altitude 30°, azimuth 172°.

The cosmic cloud apparently remained stationary for 22 minutes, and during this period the wind velocity at the earth's surface ranged from 8 to 10 miles per hour from the southwest. After the explosion the length of the cloud appeared to be about twice the apparent diameter of the full moon, and its width about half its length. Its position in the sky appeared to be east and west, and it was so high that reflections from the far-set sun were very pronounced, particularly on two of the denser portions of the dissipating dust. The cloud disintegrated into several parts, and spread out laterally and downward toward the east and west. Apparently it did not come fully under the influence of the forward movement of the atmosphere until about nine minutes after the explosion, and this would indicate a very thin, rarefied condition aloft.

Reports of detonations from the explosion, covering many points in the central and northern parts of the State, range from 1 to 10 minutes after the phenomenon was observed, with an average of about 3 minutes. Several observers reported two or three distinct explosive sounds, resembling distant thunder.

Observations indicate that the explosion of the meteor occurred over a point in southeastern Cherokee County, somewhat to the southward of the village of Wilkinsville, possibly near the junction of Gilkins and Thickety Creeks.

NOTE.

In his complete report of this meteor, Mr. Sullivan presents a large amount of data, including more than a hundred observations of its direction, and a few fairly accurate azimuth readings, as already noted. These all agree very closely in locating the section of the country above which the meteor appeared. Unfortunately no instrumental, and only a few eye observations, of altitude angles were obtained, and among these there is considerable discrepancy. Probably the most complete and reliable record of the movement of the meteor cloud was made by Mr. J. W. Ruff, industrial power engineer of the Charleston Consolidated Railway & Lighting Co. His observations were made by eye, but were later verified by a transit, using certain objects, such as trees, house tops, etc., as references. These readings, and some that have been furnished by other observers, indicate that at the time of explosion the meteor was at an altitude of practically 95 kilometers. Soon after this time the cloud was aparently about 2 kilometers long and 1 kilometer wide.

There seems to have been some conflict of opinion as to whether the cloud actually moved or not; but at the height computed above even a considerable movement might take place without being noticed, unless the observer was using an instrument. Summarizing the collected data, and giving greatest weight to that furnished by Mr. Ruff, it is evident that the cloud had a very marked eastward movement, averaging during its visibility about 250 kilometers per hour. The lower portion moved more rapidly than the upper, the difference in velocity being about 5 kilometers per hour for each change in altitude of 1 kilometer. At the time o fdisappearance the cloud was about 1 kilometer long and less than half as wide, with a depth of about 7 kilometers. During its visibility the denser portions settled about 8 kilometers and the lighter portions but a few kilometers, showing that, even at that height, the light particles were held practically in suspension by the rarefied air. Its final disappearance was probably due to its dissipation and to the passing above it of the rays of the far-set sun.

Meteoric observations are of value to the meteorologist chiefly because they furnish information concerning the height of the atmosphere and the direction and velocity of motion of the air at great altitudes. The successful reduction and practical use of such observations depend upon the accuracy and number of observations of the altitude and azimuth angles. The altitude angle, preferably measured with an instrument, or at least checked by an instrument, is of prime importance. The angle should be read at some definite time or times, for example, at first and last appearance, or at some definite point in the meteor's path. If the meteor leaves a visible trail or cloud it is very desirable to have as many successive readings of its altitude and azimuth angles as possible, so that its movement may be accurately plotted.

In collecting data on such a phenomenon a scheme similar to the one used by Mr. Sullivan seems worthy of adoption. It consists in arranging the information gathered from all sources in tabular form under the following headings:

1. Position of the observer.
2. Altitude and azimuth readings (also whether by eye or instrument.)
3. Time of occurrence, or of appearance and disappearance.
4. Brief description of phenomenon.
5. Accompanying phenomena, and any other notes.
6. Name of observer.

If the phenomenon attracts considerable attention, enough entries under each of these headings can probably be obtained so that their reduction will add materially to our knowledge of the movements of the atmosphere at heights where observations by any other means are impossible.—*W. S. Cloud.*

Monthly Weather Review.

Estimating Intelligence

THERE is a general belief that it is a relatively easy problem to estimate a person's intelligence by looking at him; and teachers, physicians and employers are often compelled to make judgments as to the intelligence of a given person with no more data than can be obtained from a rapid survey of his appearance; hence such phrases as "he looks bright" or "he looks stupid." Even in the law courts rough estimations of intelligence are sometimes required. In the *Psychological Review* (Vol. XXV, No. 4), Mr. R. Pinter gives the results of an investigation he made for the purpose of testing the trustworthiness of these judgments. The author chose 12 photographs of children varying in intelligence from proved feeble-mindedness to unusually great ability, and asked groups of people to arrange the photographs in order of merit for intelligence. His groups consisted of physicians, psychologists, teachers and miscellaneous people. He found that the group of psychologists was the most nearly correct, but that on the judgment of no one group or of no one person could any reliance be placed. Several observers were consciously influenced by children of their acquaintance whom a photograph happened to resemble, and irrelevant trivialities quite frequently biased the observer's judgment. The author concludes that, although perhaps a living person would be easier to judge than a photograph, nevertheless, these haphazard judgments are too untrustworthy to be of practical value; and that, whether the observer be a teacher, physician, or employer, it would be better to use objective standards, and he recommends that the use of mental tests should be considerably extended.—*Nature.*

Couch Grass as Malt-Adjunct in Brewing

IT has been proposed in Germany to utilize the rhizome of couch grass (*Triticum repens*) as brewing adjunct, in view of the present scarcity of malt. The dried rhizome yields about 20per cent of extract, derived chiefly from a reserve carbohydrate, triticin, which forms lævulose on hydrolysis. The practical difficulties attending its use in brewing are very great, for it is a very bulky material and requires 10 to 15 times its weight of water in mashing. Mashed alone, it was found to produce worts dirty red in color and not altogether pleasant in odor and flavor. These worts developed a peculiar odor during fermentation and the corresponding beers became undrinkable after storage.—*Note in J. Soc. Chem. Ind. in an article by F. Koritschoner in Chem. Zeit.*

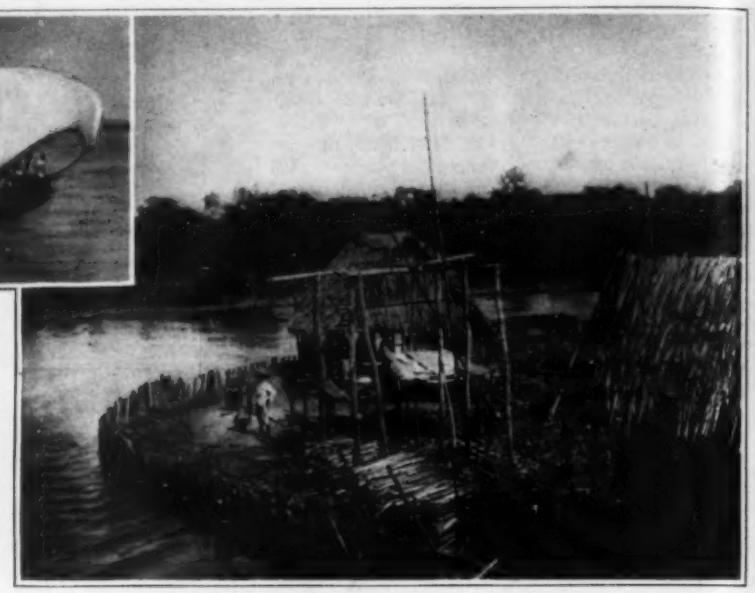
Standard Weights

A RECENT publication issued by the Bureau of Standards of considerable interest and value is entitled The Design and Test of Standards of Mass (Circular No. 3), copies of which may be obtained from the Bureau.

This circular treats of the types of weights used as standards of mass and of their design, test, and adjustment. Information is given relating to the manner of using weights, and complete routine for their verification, test and intercomparison is developed. Tables facilitating the comparison of tolerance and precision of corrections, and the computation of corrections, are included.

Photos by the Author

A native dug-out made from a single log



Native hut with high and low water foundations

Transportation on the Magdelena River, Colombia

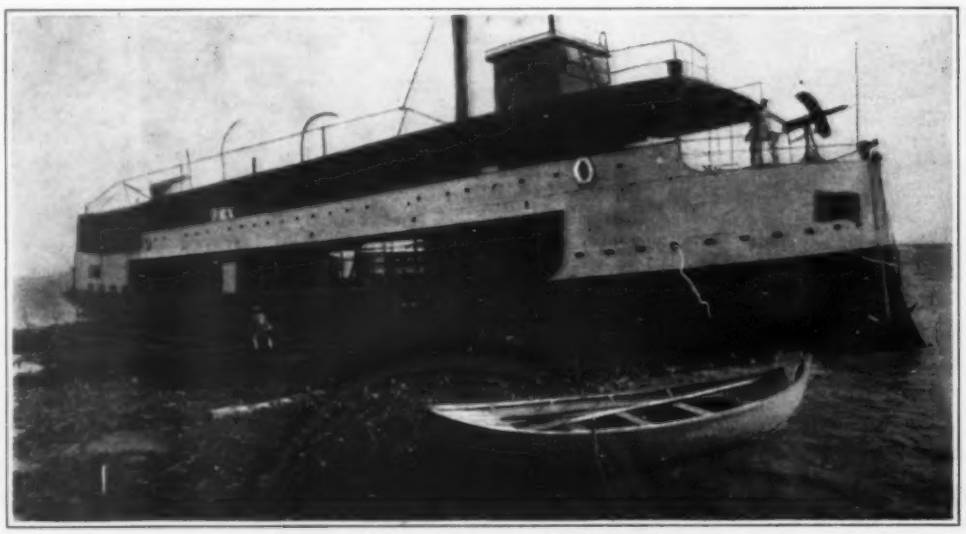
Unique Methods on One of the Most Interesting Rivers

By Hamilton W. Wright

COLOMBIA is one of the least known of the South American Republics although in several items of its natural wealth it is one of the richest. The greatest obstacle to its progress is undoubtedly the almost total lack of modern transportation facilities between the sea coast and the interior. There are few countries in the world of equal area (it embraces approximately one-half million square miles) and resources that are as deficient in modern transportation.

Despite this fact, however, Colombia has managed to carry on a very considerable commerce. The unique methods employed constitute one of the real wonders of the country. Colombia has been able to ship from the interior as much as $16,600,000 worth of coffee to the United States in a single year, the crop coming for the most part down the majestic Magdalena river, the great artery of Colombian commerce. The export of gold has averaged about $600,000 a year and of platinum about $600,000. Hide exports normally run close to $300,000 and panama hats touch the high water mark at $1,200,000. These products as well as tropical gums, dyewoods, hardwood, ivory nuts for button manufacture and the manufactured buttons come almost solely from the interior. In return there is a constant demand for manufactures both staples and luxuries such as are consumed throughout Latin-America.

The resultant commerce is borne to and from the distant interior by the most varied means of commerce imaginable. Goods unloaded from ocean-going vessels at Puerto Colombia, on the Caribbean sea, go by rail to Barranquilla, 17 miles distant, and situated on estuaries leading from the Magdalena river whose waters, as they enter the sea, are too shoal to admit any but the smallest craft. If destined to Bogota, the capital of the republic, the goods are transferred at Barranquilla to river steamers and pass up the picturesque Magdalena river to La Dorada, six hundred miles south, and the southern terminal point of the first portage. From La Dorada both passengers and freight are carried by railroad trains around the first rapids, whence they again reach the river and are embarked on smaller river steamers than those used below La Dorada, for Beltran, two hundred miles further up the river. At Beltran they again take the railroad to Girardot and thence ascend to Bogota, 8,300 feet above sea.



Armored river cruiser on the Magdalena River

This means that the freight must be transferred at least six times between the sea coast and the distant capital. But it not infrequently happens that when goods are consigned to far interior points, in addition to the transshipments and conveyances above described, they are paddled hundreds of miles in canoes or dongas up tributaries that steamers cannot penetrate, and upon reaching the limits of navigation they are transferred to the backs of mules or even domesticated tapirs. Finally in the steep ascents they are borne on the backs of sturdy Indians who plod for days between the tropical lowlands and the heights of perpetual snows and glaciers. I recall one day seeing what appeared to be an animated square box bobbing up and down grotesquely on the steep mountain trail ahead. Investigation disclosed that a small but sinewy built Indian was carrying a seven-foot crate of heavy plate glass up the mountain side. Some wealthy Colombian had no doubt sought far afield for luxuries.

Ancient monastery at Cartagena

The articles of commerce that find their way down the Magdalena, primarily reach the river through the same strange avenues. Once they have reached the great waterway it must not be understood that their various transshipments are necessarily slow or expensive. Indeed the Indians become so adept at handling freight, and their labor is so cheap, that not infrequently they can compete with modern methods. I recall a case of this kind, though not in Colombia. Coffee was brought down from the interior of Salvador on the backs of mules, transferred by lighters to steamers 2½ miles out in the open roadstead, shipped north to Salina Cruz, Mexico, carried by the Tehauntepec railroad to Puerto, Mexico, thence shipped to Havre, France via New York. Despite the transshipments this routing was steadily held in competition with the Panama Canal. So it is in Colombia; the Indian labor is very cheap and transshipments are swiftly made.

A wonderful panorama of the tropics is seen in the ascent of the river. Brilliantly colored birds, malaws, pigeons, hornbills, humming birds and orioles flit across its surface from one bank to another. At times forests draped in clinging laceries of vines crowd to the water's edge on either side. Beautiful butterflies and dragon flies sometimes fly in swarms over the water. Monkeys are occasionally seen in the nearby tree tops, and at night the roaring of the jaguar and the screaming of the other predatory cats are heard.

The Magdalena river is more than 1,000 miles long. It rises in the southern third of the republic and with its tributaries, among which is the navigable Cauca river, it affords drainage for the central part of Colombia. At the close of the verano or dry season, lasting from the middle of November till April, the river becomes very low, and not infrequently it then requires three weeks to make the trip from Puerto Colombia on the Caribbean to Bogota, the capital. At the end of the summer season, when the snows from the lofty mountains have practically melted, and the fierce tropical torrents have

Busy canal at Barranquilla and the market place

filled dry creek beds with rushing cataracts, the Magdalena rises and rolls down stream at the rate of seven or eight miles an hour in its narrower parts. Frequently the water of the main stream backs up in the estuaries. One of the pictures herewith shows the resultant condition when the Indians are obliged to move their huts to still loftier stilts to escape being engulfed by the raging yellow torrent. In this case, as will be noted, the house can be raised on its alternate foundations fully 20 feet above the level of normal low water.

For local transportation on the river long narrow steel barges, or huge wooden dugouts, often hewed or carved from a single tree, are used. In progressing up stream against the current their craft are poled by men known as poleros who seek those parts of the channel where the current is slowest. The poleros develop enormous excrescences on their shoulder pits from the constant contact of the end of the pole with their bare skin. I have seen these men at work twelve hours a day in the hot sun. The pole is placed against the shoulder and they walk from stem to stern of the boat leaning their weight against it. A real danger confronts the poleros, should they fall overboard, in the enormous number of huge crockodiles with which the river, and especially its lower estuaries and delta, are infested. I have counted more than 300 of these animals in a day, and have heard numerous stories of encounters with them. Indeed I have seen several poleros who were maimed by the brutes.

For through traffic river steamers, iron-hulled and electrically-lighted, are used. The best of the steamers are modern and make good time, although they are apt to be delayed in low water by sand bars, and at all times by stops for fuel. Cordwood is used and enormous piles of it are gathered at the fuel stations on the banks of the great stream. There are about sixty of the larger steamers on the river, of which about thirty-five are modern in build and equipment. There are numerous smaller boats used on local runs, some of which burn gasoline as fuel.

The Magdalena river was an artery of commerce before the advent of the white man. The Indians who came north through Bolivia over the old Aztec (Peruvian) trail reached the headwaters of the Magdalena from the Bogotan plateau, and continued their northward progress to the Caribbean sea by means of the great waterway. Since the advent of the Spaniards Colombia has yielded more than $700,000,000 in gold, practically all of which has come down the Magdalena. A great part of the Aztec treasures, and, later, Andean gold came by this avenue and was stored in the ancient city of Cartagena, founded in 1533, to await two convoyed galleons by which it was transshipped to Spain.

Ancient gates of Cartagena

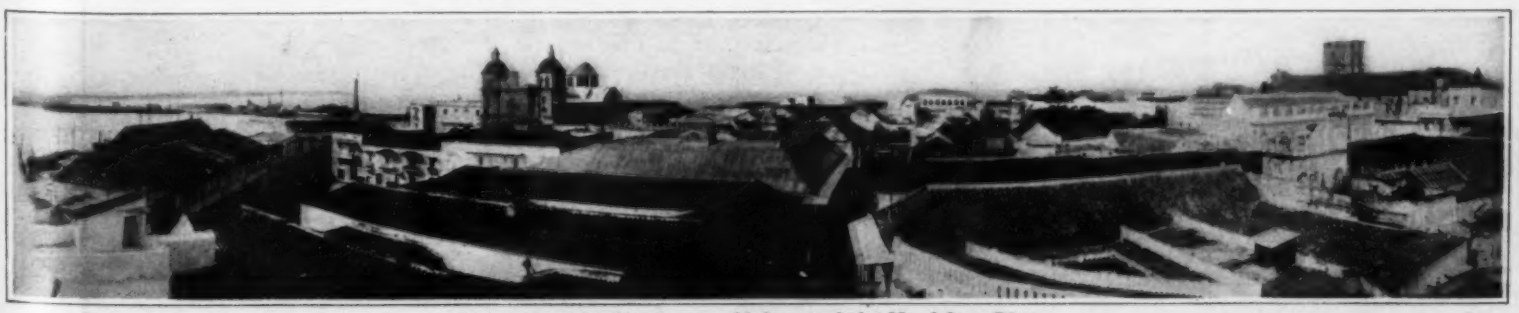
A native sail boat on the Magdalena

It is said that during a period of over two hundred years more than five billion dollars of gold and treasure has been stored within the citadel of Cartagena awaiting passage to Spain. Much of this treasure was undoubtedly brought down by the professional boatmen whose entire lives are spent upon the river.

From a scenic viewpoint the Magdalena river is one of the most picturesque streams in the world. In its lower reaches near the Caribbean it is frequently two to three miles in width, and is bordered by fertile low-lying plains already practically given to the cultivation of cotton and sugar cane, and to pasturage. The white garb worn by the dark-skinned population and negroes of the Colombian tropics, the low, narrow sailing craft with their lateen sails bellying before the wind, strangely suggest the Nile in the neighborhood of Cairo. Further up the stream the foothills of the Andes converge nearer its banks and on clear days the traveler can discern the snow-clad peaks of the Andes, the Cordillera Orient, on the left, and the purple summits of the Cordillera Centrale on the right. In the upper reaches of the river, at a distance of 250 miles from its mouth, considerable placer mining has been carried on from time to time. Indeed the negroes along the Cauca river, the principal tributary of the Magdalena, work the sands from the river bed for gold. Ascending the Cauca towards the important commercial city of Medellin there are to be found fair evidences of gold-bearing placer gravels, and dredgers are already employed in the district of which Medellin is the capital.

The great problem of Colombia, therefore, and in fact the problem of a large part of the profitable portion of interior northern South America, is to improve the transportation down the Magdalena valley to the sea. Bogota, the capital of Colombia, is so far distant from its seaport cities on the Caribbean as often to be completely out of touch with them. Indeed for more than a half century before Panama became a republic, the people of that state affirmed their problems were unknown to the legislators at the capital.

The development of Colombia will no doubt gradually bring into being a railway up the vast Magdalena valley, a step that will be welcomed by the haciendados (or ranchers) since the highland plains of eastern Colombia and western Venezuela can, it is affirmed, support no less than 400,000,000 head of cattle. When these vast plains are brought into touch with the world's markets, Colombia will become one of the most prosperous of our South American neighbors, and this prosperity will make it a great consumer of foreign goods. Even now it offers a tempting market for our manufacturers.



Cartagena, Colombia, former chief port of the Magdalena River

The Rôle of Selection in Evolution—II*

An Agency for the Elimination of Variations

W. E. Castle, Bussey Institution

[Concluded from Scientific American Supplement, No. 2248, Page 67, February 1, 1919]

In the case of certain characters in guinea-pigs I have repeatedly attempted modification of a racial character by selection within an inbred race, without success. Thus a very dark form of Himalayan albino, after a certain amount of improvement by selection, could not be further darkened to any appreciable extent. A race selected simultaneously for large size and for small size showed so little change that the experiment was abandoned after a few generations. No indication was forthcoming that we could thus ever approach in size either the small wild *Cavia Cutleri* of Peru, or the large races of guinea-pig kept in captivity by the natives of the same region. Yet evolution had in some way evidently produced these divergent conditions from a single original source. The changes were probably too slow to be observable in the life time of one observer.

On the other hand, certain characters of guinea-pigs, rabbits, and rats have been found to respond readily to selection in a particular direction. This is notably true of color patterns which involve white spotting. A selection experiment with hooded rats selected simultaneously in plus and minus directions has produced one race which is black all over except a white patch of variable size underneath, and another race which is white all over except for the top of the head and the back of the neck, which are black. The races do not overlap at all and have not done so for many generations, though they still continue to diverge from each other as a result of continued selection.

In similar experiments with Dutch marked rabbits it has been found possible by selection to increase or decrease the amount of white at will. In a series of such rabbits ranging from nearly all black to nearly all white, stages far enough apart to be certainly identifiable behave as Mendelian allelomorphs in crosses, but regularly emerge from such crosses in a slightly modified form, the whiter stages having been darkened and conversely the darker stages whitened. The principle of the pure line manifestly does not apply to these cases. White spotting is apparently a character which from its nature fluctuates constantly, such fluctuations having, to some extent at least, a genetic basis, since continuous selection invariably produces a modified race. Even in wild species, such as the skunks, white-spotting is manifestly a variable character, which no doubt will respond to the selective efforts of our skunk farmers, who desire an all-black race. Why white spotting should be a less stable character genetically than some others, it is impossible to say, but the fact is beyond question. Morgan has suggested that in general the genetic basis of a Mendelian character may be a single molecule, and gives this as a reason for believing in its constancy. But white spotting can hardly fall in with this conception. It seems to me more probably due to a quantitative deficiency in the germ of some substance which normally finds its way into all epidermal cells of the body and which is responsible for the development in them of melanin pigment. Greater and greater deficiencies of this substance cause more and more extensive white areas.

Complete or total albinism behaves very differently. It results from a complete change in some color factor which may well be a simple molecule since it appears to be incapable either of contamination in crosses or of modification under selection. Nevertheless the color factor (molecule or whatever it may be) evidently is not so simple but that it can assume at least four mutually allelomorphic forms as shown for the guinea-pig by Wright, a like number of allelomorphs, though not their exact equivalents, being known also in the rabbit.

As regards the agouti factor in mice, rabbits, and guinea-pigs, this too may assume several different allelomorphic conditions, though it is not certain that any one of these fluctuates or can be modified other than by associating with it unrelated genetic factors.

The divergent conclusions which students of genetics have reached concerning the stability of Mendelian genes and the consequent effects of selection for their modification are probably due in part to the particular choices which they have made of test cases. A study of albinism alone would lead one to believe in the fixity and constancy of Mendelian genes and the impossibility of modifying them by selection. A study of white spotting leaves one with the unshakable conviction that this form of gene is plastic and yields readily to selection. Where only genes of the former sort are involved, the principle of the pure line is applicable; where genes of the latter sort are involved, it is not applicable. The divergent results obtained by Jennings when dealing with Paramecium and when dealing with Difflugia indicate that among asexually reproducing organisms, also, genes are involved, some of which are stable, some of which are not. Accordingly, what conclusion we reach as to the applicability of the pure line theory in the breeding of animals and plants will depend upon how common we find stable and plastic genes respectively to be, and in what sorts of variations they are involved.

My own opinion, based upon a study through many years of a variety of inherited characters in the smaller mammals, inclines to the view that in such animals very few characters can safely be referred to the agency of perfectly stable genes. Even in color characters, probably the simplest as well as the most studied of inherited characters, there is much fluctuation which yields substantial results to selection by the discriminating breeder. The yellows are not all of one shade, nor the blacks of equal depth. The golden yellow of the Guernsey cow is very different from the fawn of the Jersey or the dark red of the Devon. Yet all are yellows, allelomorphs of black, but each is selected for a different standard to which the breeder must adhere very carefully in his selections, if he wishes to win prizes or sell breeding stock.

When it comes to size and shape and that consistent inter-relation of parts which the breeder calls "conformation," stable genes cannot be detected. Crosses produce blends as regards size and shape, and conformation is completely dissipated by a cross. That is why the breeder is so reluctant to resort to an outcross unless he is engaged merely in meat or wool production and is not attempting to breed to a type. *Aside from color there are very few valued economic characters in our domestic animals which are not inherited after the manner of blends.*

Weight of carcass, quality of wool, milk production in cattle, egg production in fowls—all these are blending characters which in later generations show either no segregation or imperfect segregation (fowls, Pearl[1]). I do not say that in these cases no Mendelian inheritance is involved, but merely that no stable genes are in evidence, nothing that would preclude the probable effective use of selection in maintaining or raising breed standards.

If we turn from the breeding of animals, in which manifestly the pure line principle has little applicability, to the breeding of plants other than those which are self-fertilized, we again find that this principle has a very limited applicability. Probably the most valuable open pollinated field crop in cultivation is maize. But a pure line of maize is not known to exist. An experiment which should have lead to the production of pure lines, if such a thing were attainable in maize, has been in progress at the University of Illinois for the past twenty years. Selection has been made for increased and for decreased protein content of the grain, and also for both increased and decreased oil-content, with the result that steady progress in the direction of selection has in every case been made. The high protein strain now contains twice as much protein as the low protein strain; and the high oil strain contains four times as much oil as the low oil strain. The divergence of the selected lines from each other is not now as rapid as at first but it still continues steadily, with no indication that it is soon to cease, as must be the case if only stable genes were involved.

Those characters in maize which directly affect the yield, such as size of plant, or of the grain which it bears, are blending in inheritance and show imperfect segregation subsequently. They are probably all of them quite as amenable to selection as the oil content and protein content of the seed, experimented upon in Illinois.

Finally, as evidence that even in self-fertilized plants the pure line principle may be inapplicable because of the existence of genes which are plastic, let me cite a very extensive and carefully executed piece of work on garden peas done by Hoshino. He studied the behavior of flowering time, and showed that its inheritance involves a Mendelian gene coupled with flower color (white or red). The inheritance of flowering time is intermediate, but F_1 is closer to the late than to the early parent in this character. Segregation is imperfect in F_2 with a range practically all the way from the early to the late parent, but not transgressing this range. F_3 and F_4 families from self-fertilized parents are in many cases quite variable but others are no more variable than the pure parental varieties and so may be treated as practically "constant." A study of the average flowering time of each of the 230 "constant" F_4 families shows that these fall into three main groups, some falling into a *modified early* group, not quite so early as the early parent, others falling into a *modified late* group, not quite so late as the original late parent, but most of all falling into an intermediate group occupying the region midway between the parent varieties in flowering time. Considered all together, the F_4 families "constant" for flowering time form an almost uninterrupted series of conditions connecting the respective parental conditions seen in the early flowering and in the late flowering race.

These observations show the existence of a gene for flowering time in peas which is decidedly plastic. That a gene actually exists is shown by its coupling with flower color. That it is plastic is shown by the fact that it emerges from the cross nearly always in a modified form. When the possibility of modification has been continued as long as the F_4 generation, the majority of the "constant" families are found in the intermediate or middle group. The plasticity is here shown in a tendency of the contrasted genes to blend into one of intermediate character. It is also shown in data given by Hoshino as to flowering time in parent individuals and their offspring in the late flowering variety. Although this variety is treated by Hoshino as a "pure line," it is evident that within this line itself the later flowering individuals have later flowering offspring and *vice versa*. In other words selection within this supposed "pure line" is evidently effective. Accordingly either the gene here involved is plastic or the supposed pure line is not pure.

From the various lines of evidence which have been cited (and I might have cited many more) it is clear that the pure line principle, valid as a working hypothesis for seed size in beans and for certain morphological characters in self-fertilized cereals, does not fit in with the observed facts as regards the effects of selection in the majority of the domesticated animals and cultivated plants, nor even with the behavior of certain characters in self-fertilized plants and asexually propagated animals. In the case of such characters as white spotting in mammals, it is evident that a change in the mean of the character in a particular direction in consequence of selection actually displaces in the direction of selection the center of gravity of variation, so that in a very true sense selection makes possible further variation in that same direction. The same is probably true as regards protein content and oil content in the Illinois corn experiment. It is doubtful whether, outside of that particular experiment, maize with as high a protein content as 15 per cent. has ever been observed, or maize with as high an oil content as 8.5 per cent. It is not then a misuse of terms to say that the selection has in this case been the *cause* of further variation in the direction of selection and so an agency in the progressive evolution of a new type.

If this is true concerning a single character under experimental study for a period of twenty generations, may it not also be true of entire organisms and groups of organisms subjected to keen competition with all other organisms in a struggle for existence which has continued for millions of generations? If there are characters which are plastic under artificial selection, why need we be skeptical about the plasticity of organisms subjected to natural selection? If artificial selection can, in the brief span of a man's life time, mould a character steadily in a particular direction,

*A lecture delivered before the Washington Academy of Sciences. From the Proceedings of the Academy.

[1] It is true that Pearl (1912) has described fecundity in fowls as "typically Mendelian" in heredity but his figures show that in crosses between Barred Rocks and Cornish Indian Games, the average fecundity of the F_1 birds is in both the reciprocal crosses intermediate between that of the respective parent races though nearer the racial average of the sire, which supports his contention that a sex-linked gene is involved, but shows also that this is not the only factor involved. Back-crosses of F_1 of both sexes with the pure races give evidence of further blending (or imperfect segregation) on the part of the non-sex-linked factor or factors.

why may not natural selection in unlimited time also cause progressive evolution in directions useful to the organism? I am not ready to say that natural selection is proved as the method *par excellence* of evolution, but I am not ready to abandon it as the most reasonable explanation of evolution until something better supported than the mutation theory is offered as a substitute for it. At the same time the fact should be emphasized that biology has benefited greatly from the investigation and the discussion initiated by the mutation theory. Even though the mutation theory cannot be accepted as a general theory of evolution it has done us great good in dispelling or clarifying the hazy notions which formerly existed as to what natural or artificial, is, as the mutation theory rightly holds, primarily an agency for the elimination of variations, not for their production. It can only act on variations actually existing, and while it can, I believe, continue and extend variation already initiated by shifting in the direction of selection the center of gravity of variation, it cannot initiate new lines of variation. It cannot change a vertebrate into something else nor something else into a vertebrate. It is limited to the modification of existing types of organisms, and to their modification in directions in which they show a tendency spontaneously to vary.

Discoloration of White Paint

By D. F. Twiss, D.Sc., F.I.C.

In the use of a white "enamel" of good quality trouble was experienced in the tendency of the dried films to undergo discoloration, especially when articles painted with it were stored in a fairly warm situation; under these conditions the whiteness was soon replaced by a yellow or yellowish brown color, the result being much the same whether painted surface was exposed to the light of an ordinary room or was kept in the dark. The enamel or paint normally consisted of an oil varnish mixed with zinc oxide as pigment, and at first the almost natural tendency was to attribute the discoloration to the presence of some impurity in the pigment; as zinc oxide pigment at the present time is also often adulterated with lithopone, consisting mainly of zinc sulphide and barium sulphate, the zinc sulphide in this, by slowly reacting with lead compounds simultaneously present in the pigment or in the oil, might give rise to a gradual discoloration. Although these impurities were found in some samples of the paint, not only did exposure of dried films in an atmosphere of hydrogen sulphide fail to induce a greatly accelerated color change, but samples of similar paint were discovered to be free from lithopone and lead and yet to undergo discoloration in a similar manner. A peculiarity of the discoloration was that it appeared to be confined mainly to the outer surface of the films, the under side against the painted article being affected to a relatively slight extent.

It is an interesting fact that some zinc pigments are not above suspicion as to their fastness; lithopone on exposure to light undergoes a reversible color change, which, however, is hindered by admixture with linseed oil, an extreme and probably exaggerated statement of such behavior having been made many years ago in a description of the behavior of a lithopone paint on certain gate posts, which were "black all day and white all night" (Chemical News, 1881, 43, 282). Zinc oxide, however, is relatively insensitive to light, and the fact that light was not essential to the discoloration now in question disposed of the possibility that the trouble was due to the effect of light either on zinc oxide or on any accompanying lithopone.

Another common cause of the discoloration of white paints, which is often not fully realised, is the ease with which the surface becomes stained with dirt from the external atmosphere, and, among others, H. E. Armstrong and C. A. Klein (Jour. Soc. Chem. Ind., 1913, 329) have drawn attention to the fact that the blackening of white lead paints is frequently due to this cause rather than to the action of atmospheric hydrogen sulphide. In any case the conditions under which the present discoloration occurred rendered this explanation inapplicable.

As the evidence indicated that the source of the discoloration was not in the pigment, attention was turned to the medium, and the seat of the trouble was then located. When a little of the medium was separated from the mixture and was absorbed into paper free from mineral impurities, the dried film, on being kept in a warm place, was found to develop gradually a marked yellowish brown color, a very marked change occurring in a few hours at 60° C. Linseed oil free from "gum," either alone or mixed with pigments, was found to suffer a similar alteration to the oil varnish, but in a still more marked degree.

In order to investigate the change further, strips of paper coated with the white paint, and also with linseed oil only, were hermetically enclosed in glass tubes from which the air had been expelled by a current of carbon dioxide; this gas was generated from marble and recently boiled dilute hydrochloric acid, and was then washed with water and dried with sulphuric acid before use. It was expected that under these conditions the discoloration would be prevented, but the unforeseen result was that the development of the yellow or brown color occurred even more readily. As this color change was effected in the dried paint film in a few hours at 60° C., in an atmosphere of carbon dioxide, the alteration in the oil would appear to be independent, not only of the oxidation to linoxyn, but also of the polymerisation process for which a temperature in the neighborhood of 260°—280° C. is necessary (*c. g.*, see Morrell, Jour. Soc. Chem. Ind., 1915, 105).

Tests were made as to the conditions under which the yellow or brown discoloration could be removed and the original whiteness restored. It is a matter of common knowledge that such bleaching may generally be effected by exposure to sunlight, but for convenience a Cooper-Hewitt mercury vapor lamp was used as a more readily available source of chemically active radiation. In accordance with the natural expectation, it was found that, unlike the discoloration process, the bleaching process required the presence of air or oxygen. When the discolored film, sealed in a glass tube containing carbon dioxide, was exposed to the actinic rays of the mercury lamp the discoloration persisted, although it changed somewhat in tint, becoming a shade browner. Bleached films could again be discolored by keeping in a warm place, and the discoloration and bleaching processes could be repeated many times in succession, the tendency to discoloration then appearing to undergo gradual but only slight diminution. It was not possible to prevent the subsequent occurrence of discoloration in a dried white film by a preliminary prolonged exposure to ultra-violet light with access of air.

During the course of this work the following brief reference to white paints was noted in Lewkowitsch's treatise on "Oils, Fats, and Waxes" (Vol. 3, p. 61): "The paint oil *par excellence* is linseed oil. In the manufacture of high-class white paints for the use of artists cold pressed walnut oil and poppy seed oil are employed in considerable quantities" (see also *ibid.*, Vol. 2, pp. 100 and 125). Although this statement is not definite with respect to any discoloration, it is suggestive of the possibility that white paints made with linseed oil have a less permanent color than similar paints made with the other oils named. Tests showed that poppy seed oil, apart from being paler in color when fresh, certainly has less tendency than linseed oil to discolor in this way, but a distinct, although slower, discoloration was perceptible under comparable conditions, the change in color being still less obvious, although yet distinct, in the presence of a pigment. The especial tendency of linseed oil to discoloration is masked more effectively by white lead than by zinc oxide, doubtless because of the greater covering power of the former pigment, but even with a mixture of white lead and linseed oil the gradual development of the yellow coloration is observable, the possibility of the color change being due to external causes being again excluded by the occurrence of the change in an atmosphere of carbon dioxide in a sealed glass tube. The more feeble covering power of zinc oxide naturally causes the alteration of the color of the medium to be more perceptible.

As to the nature of the chemical change underlying the alteration in color, the experiments now described give no explanation other than that it is apparently independent of the well-known phenomena of oxidation and polymerisation of the oil. Probably some minor ingredient of the oil other than the glyceride mixture which forms the main constituent is to be regarded as the cause of the trouble, but further investigation is necessary before any definite conclusion can be drawn in this direction.—*A Paper read before the Birmingham Section of the Soc. of Chem. Ind.*

Cold Work on Copper

At a meeting of the British Institute of Metals a paper was read by Mr. W. E. Atkins describing some experiments on the effect of progressive cold work upon the tensile properties of pure copper.

He remarked that while it has long been known that most metals when submitted to cold work, by hammering, forging, drawing through dies, and so on, have their physical and mechanical properties altered, but few if any attempts have hitherto been made to discover whether any quantitative relationship exists between the amount of cold work done on any metal and the magnitude of the change in its properties. In this experiments a billet of copper was cast and hot-rolled to $\frac{3}{16}$-inch diameter in the ordinary way. After rolling the bolt was annealed for four hours at about 600° C. to ensure removal of the stresses inside the metal, and was allowed to cool slowly. It was then pickled in sulphuric acid to remove external scale, and was cold-drawn by light drafts down to 0.04 inch without further annealing. From the bolt after pickling and from the wire after each draft a few feet were scrapped from the end, and three 2-feet lengths cut for testing. The successive drafts corresponded to the successive sizes of the Imperial Wire Gauge from No. 000000 down to No. 19, or 25 drafts in all. The tensile strength of the wires was determined in the Whitworth laboratories of Manchester University on a 5-ton Buckton machine reading to pounds. Five determinations were made, and these were in every case concordant within 1 per cent; the mean of the five was taken as the actual breaking load, and was converted into tons per square inch.

While the results give a smooth curve for the tensile strength against diameter or sectional area, they at the same time show that the effect of a certain amount of cold work at any stage is intimately connected with the previous history of the metal. Thus there is one stage in the drawing at which a reduction of area of almost 10 per cent (from 0.372 inches to 0.348 inch diameter) is accompanied by no change in tensile strength. The phenomena that present themselves in the drawing of copper are not of the simple nature that might be expected on the amorphous theory. That theory regards the process as continuous, in that further cold work always produces more amorphous material, and therefore gives increased hardness; but the theory, as at present interpreted, offers no explanation of the fact that over a limited range reduction in area by cold working is accompanied by no change in tensile strength. In the absence of quantitative data it appears legitimate to assume that the amount of cold work actually performed on a metal during drawing is measured by the decrease in cross-sectional area; this assumption granted, the necessary conclusion is that two distinct changes, not simultaneous, occur during the cold drawing of copper.

Density, elongation—both general and at fracture—scleroscope hardness, and so on, were all found to change in a similar way to tensile strength. Thus the density becomes constant over a limited range at 8.889, which corresponds to the specific volume 0.11251, the values for the annealed bolt being 8.9165 and 0.11214 respectively. As a tentative explanation the author suggested that the first change is allotropic in nature. After this change is complete, *i. e.*, presumably when the whole of the metal has undergone transformation, a second change sets in, which may be regarded either as allotropic or as explicable on the the lines of the amorphous theory; of the two possibilities, the latter appears the more probable.—*London Times Engineering Supplement.*

Reduction of the Oxides of Nitrogen to Ammonia Stability of Nitric Oxide

In Switzerland the conditions are such that oxides of nitrogen can be manufactured more conveniently than ammonia, so that a knowledge of the conditions under which the former are reduced to the latter becomes necessary. The authors have carried out such an investigation, using a special apparatus in which known mixtures of hydrogen with the respective oxides of nitrogen were passed over heated reduced nickel as catalyst. In order to decompose nitric oxide under atmospheric pressure, it is necessary to keep the temperature at or above 575° C. for several hours, even in the presence of spongy platinum as catalyst. Under these conditions, and contrary to what takes place under pressure, there is no formation of nitrous oxide. The primary products of decomposition are nitrogen and oxygen; on cooling, the oxygen reacts with undecomposed nitric oxide to give nitrogen peroxide. Nitrous oxide decomposes into nitrogen and oxygen. In the reduction of nitric and nitrous oxides and nitrogen peroxide by hydrogen, with nickel as catalyst, two reactions take place simultaneously, the one giving ammonia and the other nitrogen. Both in the reduction of nitric oxide and of nitrogen peroxide, the formation of intermediate products (nitrous oxide and nitric oxide respectively), does not occur. Temperatures of 250°-300° C. appear to be the best for the formation of ammonia. Below these temperatures the reduction takes place slowly, while above these temperatures the nickel gradually loses its activity and the ammonia is appreciably decomposed into its elements. Nitric oxide gives the best yields, 70 per cent of the gas on an average being transformed into ammonia; 25-39 per cent of nitrogen peroxide and only 3-7 per cent of nitrous oxide is reduced to ammonia. The reduction of the oxides of nitrogen to ammonia does not, therefore, appear to be of advantage except, perhaps, in the case of nitric oxide, where a more systematic study of the conditions may give better results.—*Note in Jour. Soc. Chem. Ind. on a paper by P. A. Guye and F. Schneider, in Helvetica Chimica Acta.*

The Detection of "Ghosts" in Prisms—I*

A Method for Developing Prisms Free from Undesirable Reflections

By T. Smith, B.A., (From the National Physical Laboratory)

THE term "Ghost" in connection with optical instruments means simply the presence of a quantity of light within the field of view which does not go to form the image which the instrument is intended to produce. This light may or may not form a definite image, and it may arise from objects within the proper field of view or it may come from a quite different direction. A second image of the proper view displaced slightly sideways in consequence of the incorrect working of prisms would be a ghost. On the other hand blurred images due to the presence of aberrations are not to be included. The method of detecting ghosts described below may perhaps be well known among optical manufacturers, but so far as the author knows no description of it has been published, and he is not aware that it has been used. Strictly speaking, it is not intended for the detection of ghosts, but for predicting whether the forms and the dimensions of prisms are such as to avoid the presence of ghosts. It is always easy to remove such unwelcome appearances by a considerable increase in the dimensions of the prism in which they arise, but quite apart from the difficulty of obtaining large pieces of glass of good quality, there are almost always serious objections to the employment of larger prisms than are absolutley necessary.

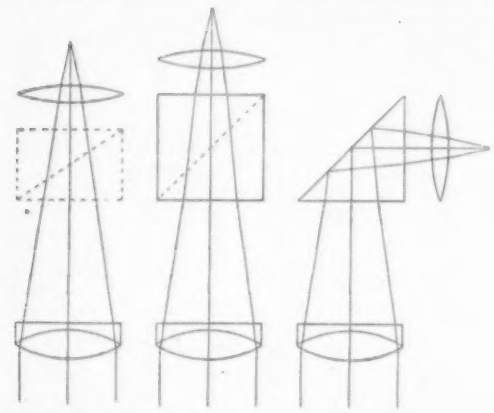


Fig. 1. Fig. 2. Fig. 3.

Ghosts nearly always arise through the occurrence of reflexions in ways that are not intended. When these reflexions take place in lenses no ghost is formed unless the ghost light has been reflected twice. Since the proportion of light reflected at each surface is small, such doubly reflected light is not often of sufficient intensity to become troublesome. With prisms a single additional reflexion may suffice to cause a ghost, and the effect is consequently much more serious. Moreover, when a prism is the first optical element of a system a single reflexion may superpose on the true image light coming from an altogether different angle; for example, an image of the Sun may be projected into the field of view and render vision almost impossible. The avoidance of ghosts in prism systems becomes consequently of the first importance.

The prisms which are most frequently employed in optical instruments are provided to deviate light without producing a spectrum or to erect an inverted image produced by a system of lenses. It is particularly with such prisms that the present note deals, though the method followed is not necessarily confined to them. The prisms are therefore optically equivalent to a plane parallel block of glass. In designing optical instruments advantage is taken of this fact, in consequence of which the alteration of the direction of rays in space due to reflexion may be entirely disregarded. For many purposes a further simplification enables the block of glass to be entirely disregarded, it being replaced by an extension of the air separation equal to the thickness of the equivalent glass plate divided by its refractive index. Figs. 1, 2, and 3 illustrate an original system, an equivalent "rectified" system, and a system with an equivalent air separation. In either of the two latter figures the complete path of any ray in the body of the prism is represented by a single straight line. This rectification so simplifies all questions in which prisms are involved that it should be used whenever possible. It will be shown that it may be applied very simply to show whether ghosts may arise in the use of prisms and if so under what conditions. For this purpose it is desirable that the method shown in the second illustration should be followed rather than the third, since in this case the actual angles at which all rays meet the reflecting surfaces are retained. The diagrams will then show whether it is necessary to silver the reflecting surfaces, and as a rule the diagrams themselves are appreciably simplified.

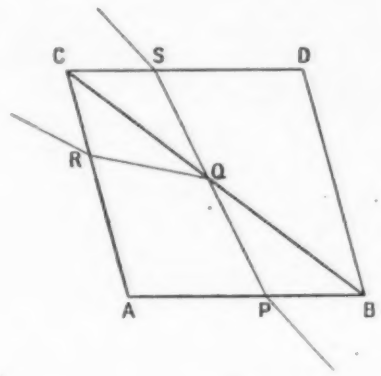


Fig. 4.

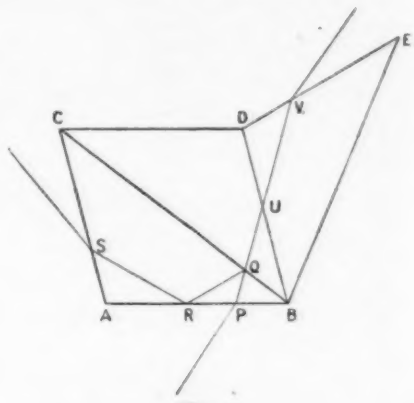


Fig. 5.

In Fig. 4, ABC represents a principal section of an isosceles prism. PQ represents any ray inside the prism which is reflected at Q on BC to R on AC. Let BCD be the position of BCA determined by revolving the triangle about BC until it is again in its original plane. If PQ produced meets CD in S, the angles CQR and CQS are each equal to PQB, and thus the path QS is exactly equivalent to the path QR and the complete path PS to the path PQR. Since the triangle is isosceles AB and CD are parallel and the prism is thus equivalent to a parallel block of glass.

Fig. 6.

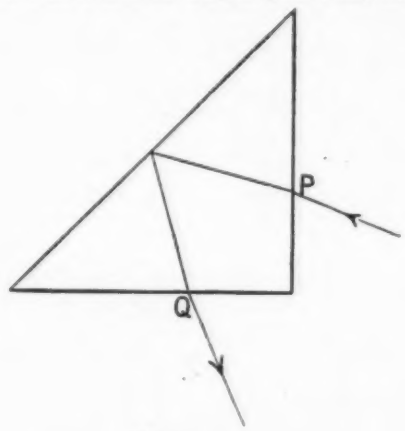


Fig. 7.

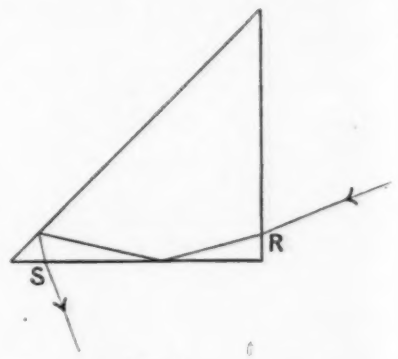


Fig. 8.

Fig. 5 shows another case which may arise in the same prism. The ray PQ after reflexion is deviated in such a direction that it meets the face AB at which it was incident before reaching AC. We may suppose that it is totally reflected at R on AB before being refracted out of the prism at S on AC. Fig. 5 shows the path PQRS rectified as PQUV. This may evidently be accomplished by rotating ABC about BC, the face at which the first reflexion occurs, to the position DBC, thus removing the change of direction at Q: and further rotating BCD about BD (which corresponds to AB the face at which the second reflexion takes place) to the position BED, by which means the second change of direction is elliminated. The complete path PQRS is thus replaced by its equivalent rectified path PQUV. The same principle may obviously be repeated indefinitely. If the triangle ABC is developed in a plane by successive rotation about its sides in all possible ways, straight lines will determine every possible path for all rays in the prism. A ray may be refracted out whenever it

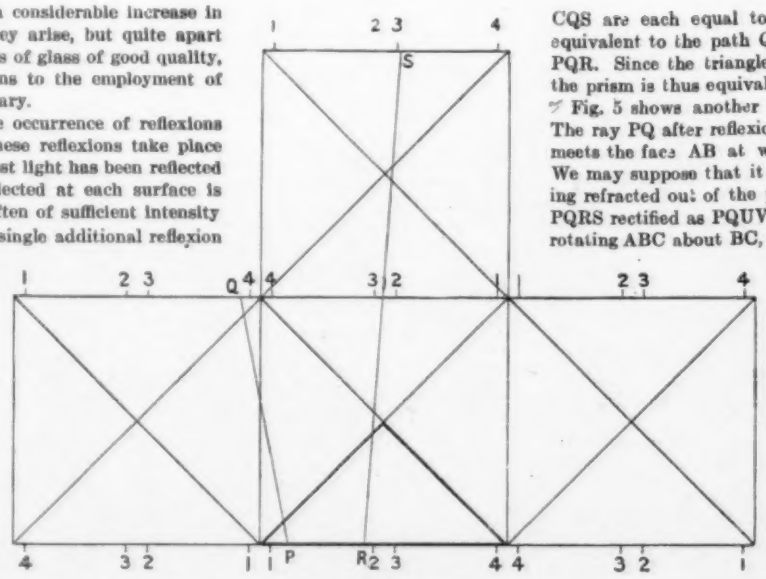


Fig. 9.

*Transactions of the Optical Society, London.

meets a side developed in the way described within the critical angle.

It is convenient to consider rays travelling in directions opposed to those in which light will traverse the prism in use. In this way all possible directions of incidence which result in a given direction of emergence are found. Some of these directions of incidence may be left out of consideration, since the face on which the incidence takes place is the same as that of emergence, and as a rule no incident light can fall upon that face. In particular cases other incident rays may be neglected, because no incident light can reach the face owing to its being silvered or otherwise shielded.

In order that no spectrum should be produced, it is necessary for the lines in the diagram representing the equivalent positions of the faces of incidence and emergence to be parallel to one another. This condition by itself is not sufficient to ensure that all rays entering as a given face and emergent at another given face will have arisen from the same object point when their final paths are coincident. The ordinary isosceles right angled prism illustrates this well. Fig. 6 illustrates its development in all possible ways. The original triangular section is denoted by thick lines, and the base and its various developed positions are marked by a short transverse line. This may be regarded as the emergent face. All other lines parallel to this not so marked represent possible incidence faces. These may be divided into two classes, those in which an even number of reflexions has taken place between incidence and emergence, and those in which this number is odd. The number is determined by the number of lines crossed by the rectified ray between the two external faces considered. The incident faces corresponding to an even number of reflexions have been marked on this diagram with a small circle. All rays that have followed paths within the prism terminated at a face so marked are deviated by a constant amount, so that a rotation of the prism will not alter their final directions if their incident directions are unchanged. On the other hand, rays which have been reflected an odd number of times will have their deviation altered by twice the angle through which the prism has turned. It is thus clear that the same emergent direction in these two cases does not correspond to identity in the directions of the points of origin of the rays, and the inclusion of rays of both kinds involves considerable risk of ghosts. The two paths PQ and RS of this figure which are parallel and so correspond to parallel emergent rays, are illustrated in Figs. 7 and 8 as they actually occur in the prism.

Fig. 6 shows that the paths which have to be considered are equivalent to paths through glass blocks of thickness proportional to 1, 3, 5, 7. . . . The brightness of the image decreases rapidly with any advance along the series, and only the first will be of importance when the prism is not the first element of the optical train. When the prism comes first and is in an exposed position the other reflexions may be of noticeable strength, but if the object is comparatively distant the various beams will be parallel if the prism is accurately made, and the multiple reflexions will be of no consequence. The diffraction effects due to the difference in the paths of the beams within the glass will not be noticeable in the strong general illumination of the field. In cases in which the beam within the prism is strongly convergent or divergent, the images corresponding to the longer paths within the prism will be sufficiently displaced from the plane of the primary image to cause no confusion to an observer. It is evident that the only rays which involve serious risks of ghosts follow a path such as RS, and also that to avoid the ghosts apertures must occur at some part of the system which will exclude a ray like RS while passing those typified by PQ. If the apertures and positions of the various lenses are all fixed this must evidently be accomplished by increasing the size of the prism until the incidence point of the extreme ray of any parallel pencil is included within a side of the diagram not marked with a circle.

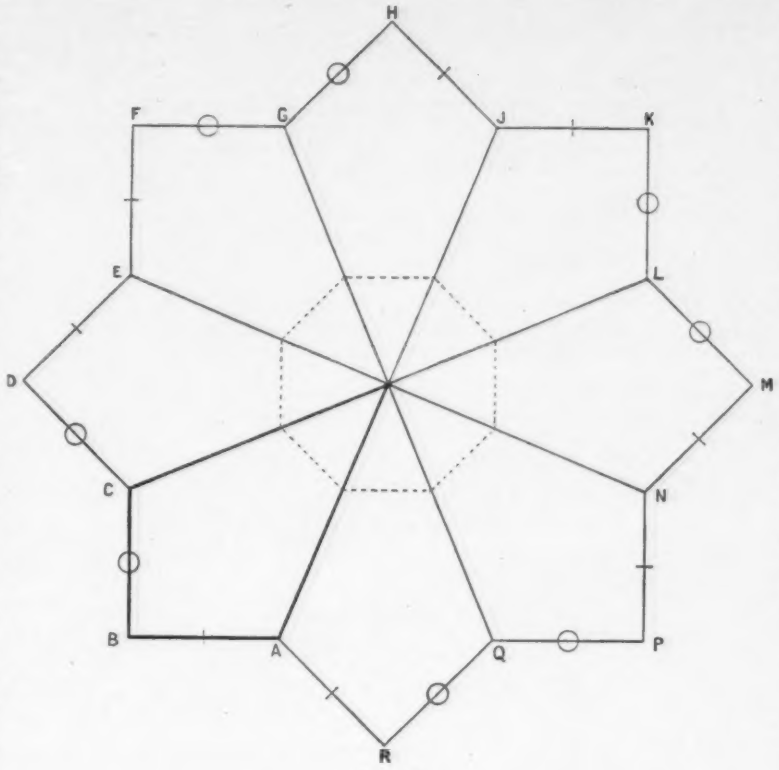


Fig. 10.

The right angle isosceles prism may now be regarded

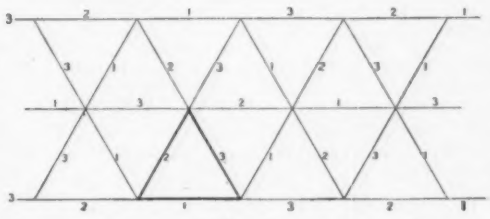


Fig. 11.

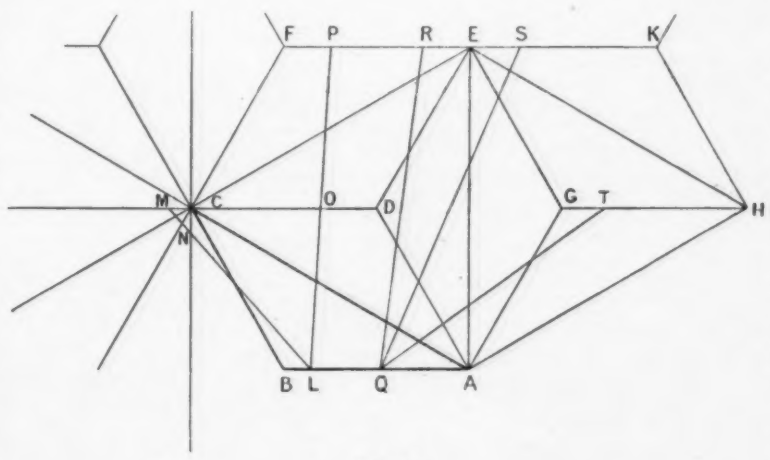


Fig. 12.

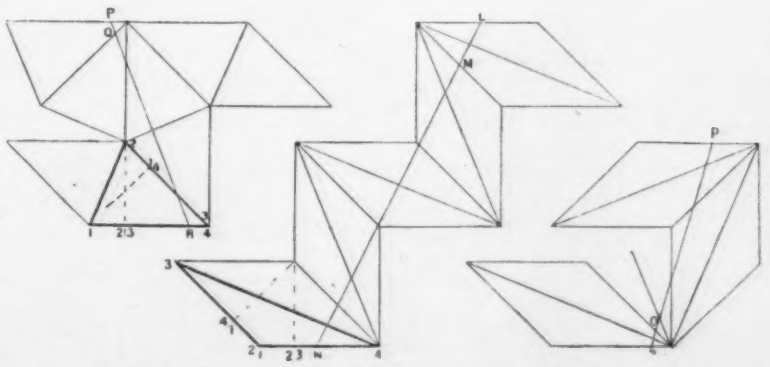


Fig. 13. Fig. 14. Fig. 15.

as a constant deviation prism, the function it serves in a prismatic binocular. For the sake of clearness Fig. 9 has been drawn, though all the properties could be derived from Fig. 6. Four points, marked 1, 2, 3, 4, have been indicated on the hypotenuse to indicate the limits of the entrance and exit pupils of the prism. It is only necessary to consider rays which start from a point between 1 and 2 and end at a point between 3 and 4. The rays producing the normal image behave like rays incident normally on the hypotenuse and the glass thickness for such rays is equal to the length of the hypotenuse. The only rays which can cause a ghost and at the same time traverse a glass block of the same thickness are exemplified by PQ, which is reflected an odd number of times. If the inclination of this ray to the hypotenuse is not small, it will be refracted out of the system at one of equal faces of the the prism and so will cause no trouble. Evidently the rays that are mischievous may be disposed of by the usual expedient of slitting the long face of the prism normally between 2 and 3, a small amount of generally scattered light then taking the place of a well defined ghost image. Another ghost may be caused by such a ray as RS, which has followed a path through the prism of twice the normal length. This may however be neglected since the image will be well out of focus.

Perhaps the prism which, after the right angled isosceles type, is most frequently used is the pentagonal prism which gives a constant deviation of a right angle. The development of this is shown in Fig. 10. As far as its optical properties are involved the prism is essentially quadrilateral; the truncation which results in the pentagona form is indicated in the diagram by dotted lines. The long sides are silvered, so that reflexion necessarily occurs there. The emergent side AB and its images are distinguished by a short transverse line, and the incident face BC and its images by a small circle. The normal path is from FG to AB with two reflexions, and therefore, constant deviation. Obviously rays following paths to AB in directions which cut HJ and JK do not occur since no incident light meets the face AB before BC. Rays in directions joining GH and AB evidently suffer total reflection at GH, and their further paths are obtained by repeating the whole diagram above H, or, what is equivalent, taking up the present diagram and moving it without rotation so that R takes up the position H. These rays thus ultimately terminate at faces corresponding to HJ or JK, and therefore do not exist. On the other side of the normal path a ray may strike EF and be there reflected; the continuation of the diagram may be represented by a translation of the diagram until P coincides with the original position of F. The ray will be refracted at the new position of PQ after three reflexions. A ghost therefore would be caused by such rays. Similarly a ray following a path from BC to BA causes a ghost; these are the only cases which can produce this result. The prism must therefore be so disposed that rays following paths from BC or EF are excluded from the final beams issuing from the instrument.

A few prisms of a less usual type may now be considered. Fig. 11 shows the development of the equilateral triangular prism. The faces have been marked by the figures 1, 2, 3. In some respects this is the ideal prism to use for the deviation of a beam of light. The diagram consists of horizontal and oblique lines, and the number of the latter meeting a horizontal at any point is always even. It follows that whenever the prism is equivalent to a parallel block of glass constant deviation can never occur. The practical limitations on its use result from the accident that our glasses have refractive indices less than 2. Fig. 12 shows the complementary prism, *i. e.*, the one which in combination with the preceding prism would make a right

angled prism. Any prism and its complement have associated properties, though these may not at first be very evident. In Fig. 12 the face AC is assumed to be silvered. The normal ray is exemplified by OL, for which CD represents an image of CB. Although this diagram agrees with the former in the positions of the lines marked 1 and 3, there is an important distinction. In the former case however the development occurs, a line in a position marked 1 is always an image of the original base line 1. On the other hand in the present diagram any given line such as EF will for some rays be an image of AB and for some rays an image of BC. If the development for the ray LOP is followed it is seen that the images of these two faces occupy in succession the following positions:

Image of AB	Image of BC
AD	DC
ED	DC
EF	FC

On the other hand the development for such a ray as QR is

Image of AB	Image of BC
AD	DC
AD	DE
CD	DE
CF	FE

Thus for LOP, the face EF is an image of AB, while for QR the same face is an image of BC. Rays emergent normally at AB are thus represented by either OL or by QR. These have followed paths of quite different lengths; the latter group are deviated by a constant amount, the former group by an amount which varies with the position of the prism. The use of such a prism would thus cause complete confusion. For oblique rays such as QS and QT, it is easily seen that EK and GH represent images of BC. In the former case the number of reflexions is odd, and in the latter even. Since however the latter ray crosses DA at a small angle, the light would be refracted at the face AB with a spectrum, the system being equivalent to an ordinary equilateral prism as used in the spectroscope. Similarly the point M for the ray LM is on an image of BC, but the ray instead of suffering constant deviation would actually be refracted into the prism at N and a spectrum would be produced.

Figs. 13, 14, 15 illustrate two prisms of special interest, the isosceles prism with the angle opposite the base 45°, and its complement. Considering first rays emerging from the base normally, it is seen that in both cases all these rays have been incident as a parallel beam on the incident face, and that no constant deviation is possible. The base may however be divided into two parts as shown by the dotted line between 2 and 3. Corresponding to the emergent points 1, 2, 3, 4 arranged in order there are the incident points 1, 2, 3, 4 but arranged in the order 3, 4, 1, 2. Thus the extreme incident rays are brought together on emergence. Moreover the length of the path in the glass for the emergent portion 3 to 4 is (1 + V2) times that for the portion 1 to 2. The prism could thus only be used in an ordinary optical instrument in positions where the light from a given point of the object examined was strictly parallel. It would however have other fields of application in physical optics, for instance in producing diffraction spectra of very high orders. It appears to possess the advantage over other pieces of apparatus designed for this purpose of being much less costly to construct, and should require much less glass than such an instrument as Michelson's Echelon. It would of course have to be constructed of very good glass, but the amount of work involved would not be great. It will be noted that so long as the prism is isosceles the angles may depart somewhat from the values shown. Perhaps the chief difficulty in the use of the prism in physical researches would be in the order of correction of the collimator employed, owing to the juxtaposition of rays from the opposite ends of the diameter of the objective. The simplest way of avoiding this would be to use two such prisms in succession; the path difference would then be doubled. A further disadvantage is the necessity for silvering or otherwise treating the reflecting face of the prism.

[TO BE CONTINUED.]

Action of *a* Rays on Metals

WHEN *a* rays strike an insulated metallic surface in a high vacuum, the metal becomes positively charged, because the *a* particles carry a positive charge and because negative electrons are emitted. This particular emission, which has chiefly been studied by H. A. Bumstead, A. G. McGougan, N. Campbell and V. E. Pound, has been distinguished as an emission of rays. The rays vary much; they may be very slow or swift; as this speed of the incident *a* rays decreases, the number of δ rays increases to a maximum, then to fall off rapidly, just as in the case of the ionisation of gases by *a* rays. While, however, every gas gives its own ionisation curve, the maximum or "knee" of which is the more pronounced the lower the atomic weight of the gas, all the metals studied give practically identical ionisation curves. It was further observed that the δ ray emission was much stronger in a newly-made vacuum than when a vacuum was maintained for some time, and was reduced by heating the metal in the high vacuum of a Gaede pump, and it looked as if the δ effect with metals was not a metallic ionization at all, but due to a film of gas on the surface of the metal. This view is supported by the most recent experiments of Mr. A. G. McGougan at Yale University, New Haven (*Physical Review*, August, 1918). The experiments are made in a brass vessel, connected with a Gaede pump, a charcoal bulb, and a McLeod gauge. On a horizontal disc, the vertical axis of which can be turned from outside, are mounted eight small discs of various metals, which by turning the disc can be brought underneath the polonium tube which emits the *a* rays. A second disc, similarly mounted, is interposed in the path of the rays so as to absorb them by aluminium foils of different thicknesses and thus to determine the ionisation curve. A scraping tool is mounted in a side tube and operated from outside by means of an electromagnet. Of the metals studied lead and gold gave the most concordant results. It was found that the δ ray emission from lead was reduced by 37 per cent. by scraping the lead surface; the new curve had exactly the shape of the old curve, though a less sharp bend; but within a day the old curve was reobtained, and after rescraping the original reduction was once more realised. Similar results were obtained with aluminium, gold, platinum, the reduction decreasing in that order; copper and silver, tried in other experiments, stood nearest lead. The arrangement was then altered so as to study the effect on a liquid surface of mercury. Instead of scraping this surface, the mercury was made to overflow the edge of the iron funnel which contained it, and the polonium was protected against contamination by the mercury vapor by a thin film of gelatine. Parallel tests were at the same time made with platinum. A slight reduction in the emission was noticed every time the mercury surface was renewed; but the full original value of the ionisation was restored almost at once. McGougan concludes from these experiments that the δ ray effect is indeed due to the gas film on the metallic surface, and not to metallic ions. That gas film is renewed on renewing the surface, either from without, *i. e.*, from the residual gas in the vessel, or from within the metal. The "soaking-out" of the gas in the metal would be rapid in the case of mercury and more or less slow in different metals. The interior origin would also be in accord with Pound's experiments on metallic surfaces distilled in vacuo. There is some hope, therefore, that distinct metallic δ rays may be deprived of their right to existence—which would be satisfactory.—*Engineering.*

Spontaneous Combustion in Hay

THE creation of extensive hay dumps for Army requirements tends to bring into prominence the question, which is ever-recurrent in agricultural practice, as to the extent to which spontaneous ignition may take place and the conditions that are favorable to it. The commonest cases of spontaneous heat production are, of course, those in which living material, seeds, leaves, etc., undergo a "sweating" process when placed in heaps, and this change, which is associated with respiratory and enzymic changes, also proceeds to a certain extent in stacks of green or fresh hay. A much more potent effect is, however, exerted by the growth of micro-organisms, bacteria, and moulds, some of which have been shown to be capable of raising the temperature to upwards of 70° C. Beyond this temperature it is doubtful whether even these organisms can continue growth, and this view is supported by the fact that only carbon dioxide, and not inflammable gas, is produced, but the high temperature already attained, and possibly the products of microbial action, serve to initiate purely chemical oxidation changes, which eventually raise the temperature to the region of 90°-95°. During this phase the hay assumes a dark brown or black color, small quantities of formic acid are produced, and there is a loss of pentosans and other nitrogen-free constituents. The latter temperature is, of course, unable to give rise to firing, but in view of the fact that substances such as bran become pyrophorus on exposure to temperatures of 145°-175°, and that energetic changes take place as low as 130°, it has been assumed that a prolonged action at the temperature occurring in the haystack may also result in the formation of similar pyrophorus substances. The presence of moisture and of easily decomposable compounds and a free air supply are predisposing conditions to excessive heating.—*Nature.*

Industrial Preparation of Argon

IN spite of the relative abundance of argon in the air the extraction of this gas by liquefaction processes is very difficult. As argon stands, for the purpose of separation, between oxygen and hydrogen, it escapes in the ordinary apparatus of the author [Abs. 149 A (1909)] together with both O and N and only in small proportions; it is possible to obtain almost all the A of the air, but very impure with both the other gases. As meanwhile argon had been isolated for use in glow-lamps in Germany and Holland by the Linde process, the author and Le Rouge resumed their experiments following up suggestions by their late collaborator Levy. When the mixture of gases escaping from the top of a rectifying column is re-liquefied and the liquid sent down the column, meeting the ascending gases, the most volatile gas is washed out of the gas by the liquid; when the collected gas is liquefied once more, and the process repeated, finally, the most condensable gas is obtained in a fairly pure state. In the case of the ternary mixture of N, O, A, the mixture finds in the upper portion of the auxiliary apparatus a bundle of tubes in a bath of liquid N, and the resulting gas is N, not A; in this way Linde gains N, together with A as by-product. By the new process of Le Rouge, the mixture is on the back-flow principle, liquefied in the lower portion of the apparatus in a bath of O. The liquefaction is only partial, and the liquid flows down the vertical tubes; the N thus escapes, and the A and O are treated as first explained, by autopurification and re-liquefaction, to yield A. The argon thus prepared is of 75 to 80 per cent and contains, besides O, 1 or 2 per cent N. This mixture is then burnt with hydrogen to remove the oxygen [Abs. 1767A (1910)].—*Note in Sci. Absts. on a paper by G. Claude in Comptes Rendus.*

Determination of Arsenic in Dead Bodies

THE organic matter is destroyed by mixing 10 grms. of the material with 5 grms. of potassium permanganate and 10 c.c. of sulphuric acid (1:5), and evaporating to dryness on the water-bath. Then 25 c.c. of concentrated sulphuric acid is added, and also hydrogen peroxide solution, until the mixture is decolorized. It is then transferred to a Kjeldahl flask, 30 c.c. of sulphuric acid is added, and the liquid is heated to boiling over a free flame and then reduced with 5 grms. of ferrous sulphate. When cold, 50 grms. of sodium chloride is added, and the liquid is distilled into 50 c.c. of 1 per cent potassium iodide solution in a conical flask, the mouth of which is protected by a tube filled with glass beads moistened with some of the potassium iodide solution. After distillation, 0.5 grm. of crystallized zinc chloride is added to the distillate and then 10 grms. of zinc. To the mouth of the flask a long upright tube is fitted, packed in the lower part with lead acetate paper and provided at the upper end with a long strip of paper which has been immersed in a solution of mercuric bromide and dried. At the end of an hour, the strip of paper is taken out, and the color roduced compared with a series of standard strips corresponding to from 0.005 mgrm. to 0.5 mgrm. of As_2O_3.—*Note in Jour. Soc. Chem. Ind. on a paper by H. Fühner in Ber. dents. Phar. Ges.*

Gold at High Temperatures and Pressures

PROFESSOR HAROLD H. MORRIS has been experimenting with gold solutions in a steel bomb in the hope of elucidating the conditions under which free gold is deposited in Nature. His bomb is a cylinder, 12 inches long, 3 inches in diameter; with a bore of 1½ inches in diameter; it is made of vanadium-chrome steel and electrically heated. He started from gold hydroxide; this body was decomposed when heated with water up to 322 deg. C. in the sealed bomb, and metallic gold was liberated. The presence of small percentages of inorganic salts lowered this decomposition temperature by 70 deg. C. in the cases of sodium and magnesium chlorides; but calcium chloride had the opposite effect. Gold chloride, prepared by dissolving the hydroxide in hydrochloric acid, was only decomposed when the critical temperature of water (about 365 deg. C.) was exceeded; in this case the presence of all the metallic chlorides mentioned raised the temperature of decomposition to 450 deg. or 460 deg. C., and this peculiarity is ascribed to the formation of double chlorides. When gold chloride was heated in the presence of a crystal of calcite ($CaCO_3$), or magnesite ($MgCO_3$), the mineral became beautifully plated with gold crystals, sometimes in fine octahedra, sometimes in dendritic forms; the appearance of the crystals changed with the mineral. This and the first-mentioned fact, that sodium chloride favored the decomposition of gold hydroxide, while calcium chloride prevented it, seem to us the most striking features brought out. One would hardly expect that so closely allied salts would have different effects; in Nature both the chlorides would frequently be present together.—*Engineering.*

Photographs on Salted Paper*

Working Instructions for Its Preparation

By L. Cartwright

ONE of the oldest photographic processes, certainly the oldest that is now ever practised, is that known as the "salted paper process." It is, to all intents and purposes, that by which Talbot made his first negatives; but it is now only used for making prints. In this method of printing the photographer sensitises his own paper, prints it out by daylight, and tones it with either gold or platinum. It enables him to make prints on any particular paper he may prefer, provided it is pure enough, and it gives prints of what may be called the "platinotype" character; that is to say, prints in which the picture appears to be in the surface of the paper itself and not contained in any layer or vehicle lying on that surface. This is one of the best features of this method of printing.

Before describing in detail the manipulations involved in making and using salted paper it will be as well to say a few words on the *rationale* of the process. The sensitive salt is silver chloride, which is formed in the coating on the paper. This salt when exposed to light in the presence of an excess of silver nitrate very speedily darkens, but the excess of nitrate is a necessity. Accordingly, the paper is coated with a mixture of some soluble chloride salt with size, the function of the size being merely to keep the image on the surface of the paper, which is very necessary if it is to look rich and vigorous.

The particular chloride salt which is used is not very material. Sodium chloride, potassium chloride, ammonium chloride, and others have been recommended; but we have never been able to discover that there is any advantage to be gained by the use of any other than sodium chloride or common salt. Ordinary cooking salt is what we use, not the prepared table salts, such as Cerebos, since these are not the plain sodium chloride. This mixture of a sizing compound and a soluble chloride is brushed over the paper and allowed to dry.

At any subsequent time when the paper is wanted for use it is either brushed over with, or is floated on, a strong solution of silver nitrate. The nitrate reacts with the chloride, forming, in the case of sodium chloride, silver chloride and sodium nitrate. The latter may be ignored. Enough silver nitrate must be present to convert the whole of the sodium chloride into silver chloride, and leave an ample supply of silver nitrate over; if not, the paper will print very slowly, and the image at the best will be a very feeble one. For this reason many workers have recommended giving a double coating of the silver solution, but if a strong solution is used there is no necessity for this. It is usual to add a little citric acid to the silver nitrate solution, as the paper will then keep better after sensitising; but, in any case, the sooner it is used the better. We like to sensitise, print, tone, and fix on the same day.

Glossy pictures cannot be made by the salted paper process; at least, it is never used for their production. If such are required it is better to have recourse to gaslight or to p.o.p. The method is seen at its best when the paper used is a fairly stout kind, and the prints are made with a broad white margin and left unmounted. It is particularly suitable for large work, and should be tried by anyone who uses enlarged negatives.

It will first be necessary to say something of the paper for the process. The most attractive results are obtained by the use of drawing papers, such as the O.W. paper, Whatman Hot Pressed, Joynson, etc., as these papers have a quality of surface which seems to be particularly suitable for the purpose. There are plenty of other papers which can be used, and the photographer who has a fancy for any special paper can easily sensitise a sheet or two and see if it will answer.

What is required in the paper for this process is purity. It must not contain any soluble salts which may have remained over from the processes of manufacture, or these will interfere with the sensitising solution and give rise to stains and uneven action. The advantage of using the high quality drawing papers made for water-color painting and such purposes is that they can generally be relied on to be free from such impurities. If there is any doubt, a piece of the paper about half the size of a page of *The A. P. and P.* should be cut up into snippets and boiled in as little water as possible for a few minutes, and the water tested by allowing a few drops of it to fall into water made a faint pink with potassium permanganate. The color of the permanganate will not be affected if the paper is pure. There is no need to test the above-mentioned papers in this way.

Another kind of impurity which is harmful cannot be discovered in this way, and may show itself in the best drawing papers as in the commonest. This takes the form of minute metallic particles embedded in the paper, any one of which will form the nucleus of a black spidery-looking mark. It is only now and again that such marks occur in good papers, and we have to take our chance of them. If they show themselves on the white margin they can generally be taken out of the finished print with a fine pointed lancet or even a needle, if carefully done, to avoid abrading the paper.

In choosing a paper the character of its surface must have consideration. It is a common mistake to get this too rough, with the result that the final print looks coarse and granular. The hot pressed drawing papers are quite rough enough for anything up to 15 × 12 inches. The paper will look much rougher when finised than it does when it is bought, as the wetting it receives takes off much of the smoothness that has been given to it by pressing.

Having chosen the paper the first operation is to size it, should this be necessary. Some papers have already all the sizing necessary: this is the case, for example, with Whatman paper. The function of the sizing is to keep the image on the surface. It is always difficult enough to do this with papers sensitised in this way, but the sizing makes it easier. If the image is in the body of the paper, either it will look dull and sunken in, or else a great deal of silver will be wasted by going to form an image in the paper as well as on it. There must inevitably be some waste in this direction, as can be seen on holding a photograph on salted paper up to a light and looking through it. Whereas prints by other processes look weaker than before when examined in this way, the salted paper print shows no falling off, or will even look stronger, on account of the image in its pores. To determine whether sizing is an advantage, a piece of paper may have a streak of size put across it, and then be used to make a print; it will show when finished whether there is an improved image or not where the size was applied.

There are a variety of substances which can be used for sizing—gelatine, starch, resin, agar-agar, and arrowroot have all been employed. The writer has used both gelatine and arrowroot. Each is quite effective as a size, but arrowroot is to be preferred as it has less tendency to give the paper a glistening surface. Perhaps it would be well to make it a rule to use for sizing whatever is used in the salting; this would at least simplify matters by limiting the number of materials in use, and by making the salting process a repetition of the sizing.

In some of the published directions for the salted paper process we are told to immerse the paper in the size, and in some we are even told to immerse it in the salting solution. This is altogether a mistake. It fills the pores of the paper with the salt, all of which must be decomposed by the silver nitrate before there can be that excess of nitrate which is an essential of the process. Whatever the size may be it should only be applied to the face of the paper, and should be of such consistence as not to sink in too far.

Half an ounce of arrowroot may be mixed up with cold water to a thick cream, and then, while stirring it in a large basin which has previously been made hot with boiling water, boiling water is poured in until the bulk of the mixture is approximately three-quarters of a pint. A great degree of exactness is not necessary. The hot thickened solution of arrowroot is strained through muslin so as to get rid of all trace of lumpiness, and when cool is brushed over the face of the paper, taking care, if the paper is at all rough, that there are no little hollows left unwetted.

The paper is cut up into sheets of convenient size. If drawing paper is purchased it will most probably be got in sheets of "Imperial" size (31 × 22 inches), which may be divided into two or four for treatment. The first thing to be done is to scribble on the back of each piece in pencil so that it may never be mistaken for the front, which, however different it may look while dry, is easily done when it is wet.

A plain bristle brush of the "sash-tool" variety makes an excellent instrument for sizing paper. Or a piece of flannel may be well washed out and folded so as to make a strip a few inches long, three or four inches wide, of four thicknesses. This is then bent over the end of a strip of glass and held in position by a rubber band. Such "brushes" are excellent for sizing, salting, and for sensitising; but it is important to keep each to its own particular purpose and to wash it well immediately after use.

There should be no attempt to give a very liberal coating of the size. Enough should be applied to make it easy to wet the whole surface evenly, but not more. A board a little larger than the paper is useful. The paper is put on this, one end held with the fingers of the left hand, while a little of the size is taken up with the brush and quickly spread over the paper with a series of parallel strokes. The board is then turned through a right angle and a second series of strokes made across the first. It is turned again and then again, the brushing being repeated, but more lightly, and it may then be put on one side for a few minutes on a flat surface for the moisture to be absorbed, after which it is pinned up to dry. The sizing is conveniently done in a comparatively large batch, and the paper put away for use as required. It does not deteriorate in keeping; in fact, if anything, it improves. The sizing may be done at any time before the salting, provided the one is thoroughly dry before the next operation is put in hand. If the coat of size is insufficient a second may be given at any time after the first is dry. It is better to do this than to attempt to apply one thick coating.

As already mentioned, there are many papers which do not need sizing, but can be salted just as they are. The salting solution invariably contains some ingredient to act as a size to help to keep the image on the surface of the paper. There are an enormous number of formulæ for salting solutions, the wide variations in which suggest that the exact proportion of the ingredients is not a very vital matter. In one sense this is true; that is to say, from suitable negatives capital prints can be made with solutions varying in strength in the proportion of five to one or even more. But to do this the negatives would have to vary, and when one writer urges one strength as being the best, and another recommends some totally different strength as correct, all that can be gathered is that the first suits the negatives made by the one and the second those made by the other. The salting solution described below is an average one, and after trial may be used stronger or weaker as preferred.

To prepare the salting solution, a batch of arrowroot sizing is made exactly as described above with one exception; but a smaller quantity will probably be sufficient. The exception is that, instead of adding plain water to the arrowroot, we add water in each ounce of which twelve grains of common salt have been dissolved. If preferred, ammonium chloride may be substituted for the salt; it seems to make little if any difference to the result. The salt solution must be boiling when it is added to the arrowroot, and the mixture is filtered and applied to the paper in the way described above.

One must be very careful, when applying the salting solution, not to spill any on the back of the paper, as, although it will show no mark at the time, it will appear as a stain on the finished print, which may easily affect the image on the front, weakening it. A second coat of the salting solution may be given, if preferred; it is better to do this, if a rich coating is required, than to attempt to get it in a single operation.

All the operations up to the sensitising with silver are best carried out by daylight, or in light which allows us to see comfortably what we are doing. Neither the paper nor the solutions are light sensitive at this stage. The salted paper, when dry, keeps indefinitely. The next operation makes the paper sensitive, and after sensitising the sooner it is used the better.

Sensitising can be carried out in very weak daylight; but good artificial light is better, as we can then have as much light as we like, can see what we are doing comfortably, and need not hurry. The sensitising liquid which we prefer is a solution of silver nitrate to which a little citric acid is added. Some of the published formulæ give what is called ammonio-nitrate of silver for the purpose, made by adding strong ammonia to the solution of silver nitrate until the precipitate which first forms is just redissolved. It makes the paper print a little more quickly, but it does not keep so well, and, in our opinion, does not work so cleanly as the plain nitrate.

A good medium-strength silver bath for salted paper

*From *The Amateur Photographer and Photography.*

is one of sixty grains to the ounce, which is easily made by dissolving an ounce of silver nitrate as bought in water to make eight ounces in all. It is cleaner to use distilled water for making up this solution, as there is then no precipitate. If tap water is used there will be a white precipitate, which in course of time will go black. This does no real harm; it weakens the solution in silver, but quite imperceptibly; and the clear liquid may be decanted for use or the precipitate filtered out. We leave it in the bottle, pouring off what we want from the top. The silver solution keeps indefinitely. To each ounce of the silver solution just described, twenty-five grains of citric acid are added, and when dissolved the liquid is ready for use.

An alternative method of making the silver solution is to weigh out, for each ounce of liquid that may be required, sixty grains of silver nitrate and twenty-five grains of citric acid. Then, taking the total quantity of water, it is divided into two equal parts, the silver nitrate being dissolved in one of these parts and the citric acid in the other. When both are dissolved the two solutions are mixed.

The amateur coating only a small quantity of paper at a time will find that the cheapest and easiest plan of doing so is to apply the silver solution by means of a "brush" made of flannel, already described. Or he may use a camel-hair brush; but this must be one in which no metal has been used. It is applied in the same way as the salting solution, except that the brush should be dipped in the solution after each stroke, and a little more taken up; but it must not be applied so liberally as to lie about in pools on the paper.

As the silver solution is a comparatively costly one, it should be taken care of. If the paper is floated upon it the solution which can be poured back into the bottle after use, as long as it lasts, will be found to get gradually weaker and weaker. To remedy this, it should have more of an unused solution added to it from time to time, and in making up this solution it is well to have it in a more concentrated form. We may take three-quarters of an ounce of water instead of one ounce, in which to dissolve the nitrate and citric acid, and so by adding some of this we may keep the solution up to full strength. One can only tell that it is getting weak from the paper yielding prints which are a little softer in contrast, and until this becomes noticeable there will be no need to add any of the stronger solution.

By sensitising with a brush, pouring out just enough of the stock solution of silver nitrate for the work in hand, so that we do not have to pour back any of it, all need for strengthening is removed. On the whole it is the better plan. It has the added advantage that the silver bath is of definite composition, no matter how long it may be used, none of the by-products of the reaction of sensitising getting to it.

If there is a fire in the room, it is a good plan to hold the paper near it, so that it dries quickly; but it must not be made hot. A second coating may be given if the negatives are at all thin. When dry, the paper should be put in a drawer or other dark place until it is wanted for printing. The best results will be got by drying the paper in a warm room and printing it straight away.

The Present State of the German Merchant Fleet

BEFORE the war the German merchant fleet amounted to 5,134,720 tons; of this total some 2,500,000 tons have been taken, one way or another, by hostile countries. Further losses and dilapidations have occurred during the war, and now not more than 2,000,000 tons can be reckoned upon as being available in German ports. It has been rumored and even stated with some authority, that energetic and extensive building to make up for this has been going on at the German shipyards, but this can hardly be correct. Since 1916 the naval and military authorities have monopolised the yards, and since the autumn of that year, with a few isolated exceptions, all building of mercantile tonnage has been entirely prohibited. The vessels which were taken in hand or contracted for in 1914 are consequently not ready yet. In April, 1917, the Hamburg-America Company, for instance, had contracted for 16 large boats of an aggregate tonnage of 323,000 tons, and the North German Lloyd had a similar number of vessels ordered with an aggregate tonnage of 216,000 tons, 25 additional vessels with a tonnage of 325,000 tons being ordered by four other shipping companies. According to what Herr Ballin stated shortly before his death none of the above vessels had then been completed. The few boats for which the necessary permits had been obtained were only some iron ore boats for the Baltic trade and a number of trawlers of service to the naval authorities.

The normal output of the German yards before the war amounted to some 300,000 tons. All the old yards have materially increased their plant and capacity during the war and a fair number of new yards have sprung up, so provided an adequate supply of raw materials can be secured, the capacity may have been about doubled. The loss of Alsace-Lorraine and of the occupied districts, however, will to a substantial extent reduce Germany's former supply of ore.

The Act of last year providing extensive State aid to the rebuilding of the German merchant navy caused the works to be simply flooded with orders.

The financial position of the German shipping concerns has steadily deteriorated during the war; no reports have been forthcoming as far as most of the leading companies are concerned, and with a few exceptions the shareholders have received no dividends. Several amalgamations of shipping undertakings have been completed, and some concerns have been bought up by leading industrial companies. In this direction Herr Hugo Stinnes has been particularly active and has now became one of the leading men in German shipping. He is understood to have contracted for over 250,000 tons of new tonnage during the war.

The *Vorwarts*, some little time ago, dealt with the future of German shipping and took a very pessimistic view. The expenses of shipping after the war would, thought the paper in question, be so heavy that the State subvention would not by a long way suffice to meet them. On the other hand the shipbuilding industry was likely to be very prosperous for the first five to six years. The number of older German yards is put at 22, of new at 20, with an aggregate of 50 new slips. Germany more than any other country will be in need of tonnage; imports sufficient to cover the country's most important requirements are estimated to represent a value of from 12,000,000,000 marks to 15,000,000,000 marks, for the carriage of which a vast amount of tonnage is needed. Regulations have been drawn up so as to ensure a gradual import of the different commodities according to their importance.—*Engineering.*

The Cross-sections of Artificial Silks

THE cross-sectional contours of artificial silks are a characteristic indication of the physical conditions of spinning and therefore a useful guide in the identification of origin. The first basis of classification is the manner of coagulation, viz.: coagulation by evaporation in air and coagulation by precipitating liquids. Other things being equal, threads formed by precipitation tend to be neither so strong nor so transparent as those formed by evaporation, since precipitation implies discontinuity. As a rule the silks formed by precipitation show a more or less circular contour in the cross-section; those produced by drying show peculiarities which influence their industrial application. Collodion silks are produced by the Chardonnet process in both ways. When spinning by coagulation in water, a very fluid collodion is employed containing, for instance, 50 grms of pyroxylin per liter of alcohol-ether. When the fluid thread emerges in a cylindrical form from the spinning orifice its surface is immediately coagulated on contact with the water, and the film so formed, although very thin, preserves its integrity and, during the drying of the thread, it is folded up on itself as the cross-sectional area is reduced to correspond with the final solid volume. The cross-sections of threads spun under such conditions show re-entrant angles and have generally a stellate contour. If a thicker collodion be spun in the same way, the ratio between the original volume and the final volume of the thread is not so large and the irregularities of the cross-section are less pronounced. With a little practice, the concentration of the collodion may be estimated by an examination of the sections. When spinning into air, very much thicker collodions are employed, *e. g.*, 200-250 grms. of hydrated pyroxlyin, containing about 26 per cent of water, per liter of solvent, and, on the one hand, coagulation takes place far less rapidly, while on the other, the final solid has a larger sectional area. Hence it follows that the contour is much less wrinkled and the sections have a flattened curved shape. The "covering power" of the silk increases in inverse ratio to its apparent density and, other things being equal, silks with round and regular contours cover less space. In this respect the collodion silks, particularly those spun in water, possess an advantage; but other considerations have favored the process of spinning in air, and the superior covering power of these threads is sufficient to compensate for the slight difference in real density as compared with natural silk. Laboratory samples of extreme fineness having perfectly circular cross-sections may be prepared from a solution of 2 to 3 grms. of pyroxylin in 60 grms. of alcohol and 40 of ether by spinning into dilute alcohol. The alcohol retards the drying of the surface of the thread, so that the center dries as fast as the periphery and the cylindrical form is preserved.—*Note in Jour. Soc. Chem. Ind. on a paper by De Chardonnet in Comptes rend.*

A New Textile Fiber

A CHEMNITZ manufacturing company has succeeded in producing a useful substitute for cotton and jute from pine-tree needles. These needles are treated chemically and then prepared by machinery. The finished material can be spun on any cotton-spinning machine. The spun yarn breaks less easily than paper yarn and is also more elastic. This company also manufactures a very serviceable, watertight and pliable substitute for shoe leather.—*Z. angew. Chem.*

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